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Descriptors-*Audiovisual Instruction, Braille, Case Records, *Communication (Thought Transfer), Communication Skills, Cybernetics, Electromechanical Technology, Equipment Evaluation, *Exceptional Child Research, Input Output Devices, *Instructional Materials, Language Arts, Man Machine Systems, *Multiply Handicapped, Perceptual Motor Coordination, Systems Development, Typewriting
Identifiers-Cyberbrailler, Cybercode, Cybercom, Cybergenetics, Cybergloves, Cyberlamp, Cyberphone, Cyberplate, Cybersem, Cybertac, Cybertype, Cyberview, HAIBRL

Newly developed communications systems for exceptional children include Cybercom; CYBERTYPE; Cyberplace, a keyless keyboard; Cyberphone, a telephonic communication system for deaf and speech impaired persons; Cyberlamp, a visual display; Cyberview, a fiber optic bundle remote visual display; Cybersem, an interface for the blind, fingerless, and others with limited control; Cybertac, a tactile communications technique for the blind, utilizing palpable vibrations; Cyberbrailler, a system for simultaneous printing of braille and typed letters via Cybercode dual inputs; Cybergloves, transducer-fitted gloves, and HAIBRL, an unambiguous punctiform tactile communication system utilizing reference perforations. Three blind, five multiple impaired, two bilateral amputees, and two deaf subjects were tested on the new mechanisms using experimental instructional materials. The latter include Cybertype Exercise Series, a child's circus story guide, and language arts exercises. Initial results indicated that the systems were capable, reliable, and effective in assisting handicapped subjects to communicate. (Author/RP)

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Interim Report

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STUDY OF MAN-MACHINE COMMUNICATIONS SYSTEMS FOR THE HANDICAPPED

August 19, 1968

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

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RE: *Interim Report dated August 19, 1968*
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TO BE INSERTED:

ACKNOWLEDGEMENTS SECTION - Page iv

fourth line from bottom of fourth paragraph; following last word on line ("Veterans") *PLEASE ADD:*

Administration; Walter G. Leight, Senior Operation Research Analyst

SECTION VI - CONCLUSIONS AND RECOMMENDATIONS - Page 41

sixth line from top of first paragraph; following last word on line [(c) a] *PLEASE ADD:*

need for

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STUDY OF MAN-MACHINE COMMUNICATIONS SYSTEMS FOR THE HANDICAPPED

Haig Kafafian

CYBERNETICS RESEARCH INSTITUTE

Washington, D. C.

August 19, 1968

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PREFACE

This report covers an educational research program, under major sponsorship of the U. S. OFFICE OF EDUCATION and in part by CYBERNETICS RESEARCH INSTITUTE. It deals with determining the feasibility of new man-machine communications systems as applied to the education of multiple-impaired children and youth. One of the mechanisms used in the program employs CYBERTYPE® , a component or subsystem of Cybercom.[1]

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[1] Trade-mark

ACKNOWLEDGEMENTS

CYBERNETICS RESEARCH INSTITUTE (CRI) gratefully acknowledges support received from the PROJECTS AND PROGRAM BRANCH, DIVISION OF RESEARCH, BUREAU OF EDUCATION FOR THE HANDICAPPED, and especially the multiple-impaired children and their parents, without whom many of the findings in this report would not have been possible.

The investigator is especially indebted to his friend and colleague, the late Professor William J. Fry, former Head, Biophysical Research Laboratory, University of Illinois, and one of the founding fathers of CYBERNETICS RESEARCH INSTITUTE, who always responded with alacrity and dedication to programs whose purposes were to better serve mankind.

To the support rendered by the Chairman of CYBERNETICS RESEARCH INSTITUTE's Board of Trustees, Professor Heinz Von Foerster, Head, Biological Computer Laboratory, University of Illinois; and the Chairman of CYBERNETICS RESEARCH INSTITUTE's Cybernetics Advisory Council, Professor Warren S. McCulloch, M.D., of the Research Laboratory of Electronics, Massachusetts Institute of Technology, the investigator is most grateful.

The staff appreciates the guidance and valuable assistance rendered by Professor Samuel C. Ashcroft, Chairman, Department of Special Education, George Peabody College for Teachers; Dr. Arra S. Avakian, Director, Eastern Operations, Aerospace Corporation; Mr. James J. Bagnall, Research Staff, Institute of Defense Analysis; Warren M. Brodey, M.D., of Massachusetts Institute of Technology; Mr. Joseph Coates, Research Staff, Institute of Defense Analysis; Dr. Joseph H. Engel, Special Assistant to the Vice President (Technical) of Communications Satellite Corporation; Mr. Roger Barron, President, and Mr. Lewey O. Gilstrap, Jr.,Executive Vice President, Adaptronics, Inc.; John P. Henry, M.D., Assistant Professor of Physiology, Dartmouth Medical School, and Associate Chief of Staff, Veterans Administration; Walter G. Leight, Senior Operations Research Analyst, Center for Naval Analyses; Dr. N. Henry Moss, Associate Professor of Surgery, Temple University Health Science Center, and Staff Surgeon, Albert Einstein Medical Center, Northern Division.

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CYBERNETICS RESEARCH INSTITUTE also expresses its appreciation to the staff at Belle Willard Elementary School in Fairfax, Virginia; its principal, Mrs. Aurelia A. Howland; and vice-principal, Mr. Victor E. Cornacchione, for their cooperation in the children's experimental training program.

The investigator also expresses gratitude to those scientists in special education, engineering and industry, whose consultations, publications, lectures and private communications have provided valuable information along with that essential ingredient: intellectual stimulation.

Although many have assisted in the preparation of this report, the principal investigator is responsible for shortcomings, errors or omissions which may arouse the reader.

][

SUMMARY

CYBERTYPE® consists essentially of three components: (1) A unique keyboard or interface which is available in different configurations and can be adjusted to match the capabilities of the individual; (2) electrical and mechanical means for converting collateral multiple inputs into single, sequential outputs (or *vice versa*), and (3) an electric typewriter or other machine, and accessories.

The 92 distinct letters, symbols and functions of one model of an electric typewriter used in these trials, were individually programmed by means of dual-input combinations which were keyed on a 14-key keyboard interface. By simultaneous operation of two keys or transducers, it was demonstrated that multiple-impaired children who could not effectively operate standard keyboards could communicate through the aid of CYBERTYPE® .

Those who were taught to use the equipment include one armless child, a child born malformed (allegedly caused by thalidomide), children with motor deficiencies, and blind children. None of the children tested could write legibly; but they learned to type basic words and their names with about ten hours of instruction and practice. [Plate 1]

It is too early in the program to ascertain constraints and scope of utility of these mechanisms and instructional materials, considering the broad population of multiple-impaired children, and, especially, the different kinds of impairments which many children have. However, the successful results obtained thus far with children who previously could not effectively write or type, indicate the worthiness of pursuing the project with even greater vigor and objectivity.

Furthermore, preliminary analyses and operational data reveal economic feasibility of the mechanisms used by the children.

COMMUNICATION SYSTEMS FOR THE HANDICAPPED

The twelve principal Cybercom variations and components studied in this program are: (1) The 'standard' 14-key interface; (2) split-interface CYBERTYPE® , each half consisting of seven keys which can be attached to wheelchair arms or to either side of a table, bed or other accommodation; (3) miniature, one-hand, 14-key keyboard; (4) Cybersem, an interface for use by

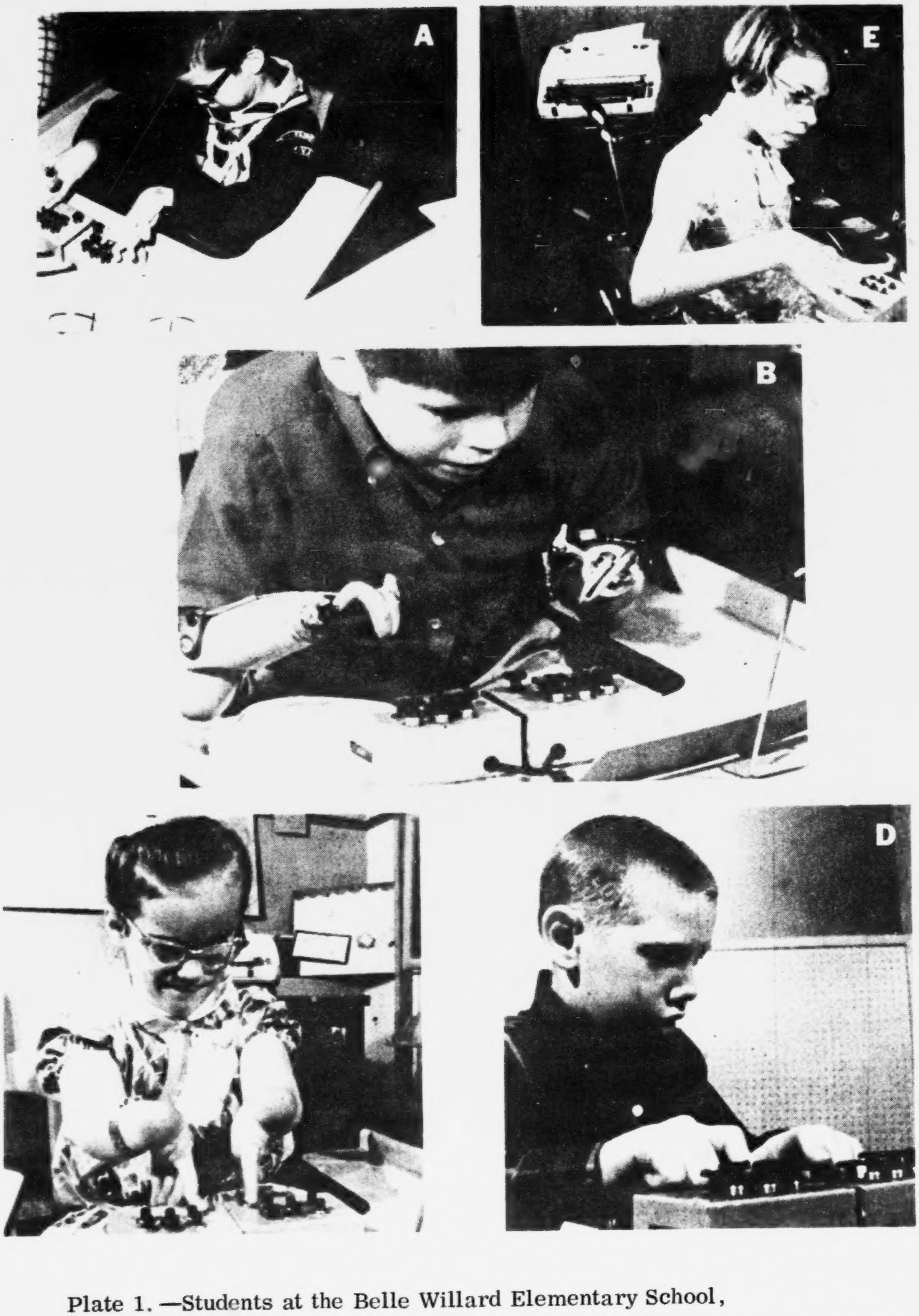

Plate 1. —Students at the Belle Willard Elementary School, shown operating 14-key, one-hand; and other, interfaces.

blind amputees and debilitated children with limited motor control; (5) Cyberplate, and (6) Cyberglove [Cyberplate and Cyberglove do not require keys for operation of the typewriter]; (7) Cyberlamp, an alphanumeric and manual alphabet visual display; (8) Cyberview, a fiber-optic bundle device which provides visual feedback; (9) Cyberphone, for telephonic communications; (10) Cybertac, a palpable vibration mechanism for tactile communications; (11) Cyberbrailler, which produces braille and standard type simultaneously, and (12) HAIBRL, a new, unambiguous punctiform tactile communications system.

Two coding programs used with CYBERTYPE® have been considered and one is being tested. Both are based on the probability of letter usage. In one of the codes, the most frequently occurring functions of letters ("space", E, T, A, O, N, I) are produced by symmetrical fingerings, *i.e.*, on the upper keybank, the two forefingers produce E, the two middle fingers produce T, and the two ring fingers produce A. Similarly, O, N, and I are achieved on the lower keybank; and the "space" position is achieved by using both thumbs. [Appendix A]

INSTRUCTIONAL PROGRAMS AND MATERIALS

Experimental Cybercodes (dual-fingering combinations), instructional programs and materials have been prepared and are being tested in the teaching of the keying positions.

The CYBERTYPE® EXERCISE SERIES [Appendix B] consists of practice sentences, common letter combinations, dexterity exercises and basic and supplementary word lists. It is aimed to reinforce motor memory of the positions for letters, symbols and functions found on the typewriter.

Another of the experimental teaching programs is a story-guide named Cyber-Circus. [Appendix C] A preliminary test of this material using children ranging from six to ten years of age created a great deal of excitement. As the children learn about the circus performers and the related acts, they are taught to associate the circus characters with the interface keying positions.

Other experimental instructional material programs, such as those based on the associative principles of Cyber-Circus, are in the process of being developed. In addition, Languages Arts Exercises [Appendix D] have been prepared to guide classroom teachers in integrating their programs into the student's regular schedule. As Dunn (1963) has stated, "It is no doubt true that any arrangement may be good or bad for a particular pupil, depending on the quality of teaching and the type of curriculum offered." Thus, we must cautiously evaluate not only the arrangements and the mechanisms, but the spirit of the students, teachers and the instructional material with equal objectivity.

INITIAL SELECTION OF SUBJECTS

Impaired children who were unable to write legibly or type properly on standard keyboard typewriters, due to blindness, congenital deformity, cerebral palsy, or multiple impairments, among others, were selected as subjects for these studies. They exhibited different perceptual motor problems and were of average intelligence. [Appendixes E & F]

An adult male bilateral amputee was taught to operate the mechanism by means of his two prostheses. Subsequently, he became part of the research team. He taught a congenitally armless boy to type in a manner that allowed the child to communicate with the aid of his prostheses and a 14-key interface.

PARTICIPATING HANDICAPPED SUBJECTS

Three blind children were tested on a limited scale. They participated primarily to determine the worthiness of various configurations of interfaces. The 14-key interfaces were clearly advantageous to the subjects tested. Using minimal arm and wrist movement, these children touch-typed, with few errors, those letters of the alphabet which they were taught to represent by movements of one finger of each hand. These finger movements corresponded to the actual key positions on the interface used.

Five multiple-handicapped children, three with cerebral palsy, comprised the second group of candidates. The interfaces, none of whose keys were labeled or identified with letters, were adjusted to fit each child's handicap. For the child who used prostheses, the interface was adjusted for "hard touch". This child gradually improved coordination of his muscles and hence the navigation of his prostheses. Another subject, with four fingers extending medially from both of her arms, learned to communicate on a split-interface, using only the small finger of each hand. She attained a high level of accuracy.

The total time of instruction for these children varied between nine and twelve hours. Investigators collaborated with educators, consultants and parents to discuss and explore educational developments of the subjects.

Also participating as subjects at CRI are two deaf women.

The purpose of this adult training has been to prepare them to teach deaf children and children with speech impairments to use the "Cybercom" mechanisms with remote visual displays via standard telephones.

FINDINGS

The subjects in this project, an adult bilateral amputee, three blind children, five multiple-handicapped children, two deaf women (and the investigators) are in the process of learning how to operate these mechanisms. One child is armless.

Functional capability and reliability of the ten Cybertype® systems were observed; no failures occurred with any of the Cybertype® and interface mechanisms. The standard electric typewriters only required routine service; such as ribbon replacement, cleaning, *et cetera*.

The instructional programs used were found to be effective. These programs and materials are still considered experimental and are being systematically improved and modified.

One striking observation was that a blind child who had difficulty spelling orally, began to "spell" correctly by manipulating her fingers in their proper dual-code keying positions while away from the 14-key keyboard. These movements of the fingers were observed by the teacher as being the very same movements required to obtain the letter represented on the keyboard. This instance suggested a possible use of the dual-coding technique for teaching certain classes of impaired children to spell and possibly to communicate with their fingers in the very same positions as required for keying. Thus, "Cybertalk", as it has been called by the author, may find applications which could help certain classes of impaired children to communicate.

Another noteworthy outcome of the first phase of the project was where a twelve year old subject with cerebral palsy, who used one hand, was observed doubling her former typing speed by means of the one-hand interface. Previously, with four years instruction, she typed at a rate of five words per minute using a standard electric typewriter keyboard. She acquired the speed of ten words per minute on the 14-key keyboard, after about seven hours of instruction. It is too early to determine the reason for this remarkable improvement. To what extent were the mechanism, the instructional material, the teacher, the machine's interface, the child's determination and other factors primarily responsible for this gross improvement?

Qualified, special education teachers observed that their students who were subjects in this program, made a notable increase of using new words which had been introduced in the training program, as well as growing confidence in the use of the machine. The interest of the subjects was further demonstrated by their reluctance to leave at the end of their training period. This was most rewarding to the teachers. The children really enjoyed working with the machines, the circus stories, the Cyber-Circus; and, secondly, their very own printed words, especially their own names, brought forth a sense of real accomplishment and gratification.

FUTURE STUDIES

Studies are anticipated for further analysis of new instructive materials and configurations of other mechanisms. Efforts will be made to meet specific needs of individuals whose varying capabilities require specialized interfaces. As Kirk (1962) has summarized, "Inherent in the philosophy of a democracy is the right of all children to develop to their maximum."

To assist children in achieving this maximum development is one of the goals of future studies.

Moreover, experimental programs are planned for the next phase of the project. Plans to teach students singly and in groups within the public school system are underway.

A movie film of subjects is planned in order to portray the before-and-after aspects of the teaching programs. Videotaping of subjects which will permit better observations is being considered.

The several adjunctive mechanisms used in this program have displayed merits which warrant continued investigation of their utility in the teaching process. New dimensions for educating the handicapped are being discovered. A totally fertile area of special education research has been exposed.

By the same token, one of the serious shortcomings of the educational profession has been highlighted, that is, the difficulty of locating qualified, special education researchers, especially those with engineering and educational psychology training and experience.

][

INTRODUCTION

One of the objectives of this research is to serve handicapped children. "The job of all educators, is to find the mechanisms through which we can translate new knowledge into action at the instructional level." [Gallagher, 1968]

Through the principles of cybernetics and the use of adjunctive educational components, the researchers have endeavored to achieve action at the instructional level.

But, since cybernetics is a relatively new science which presently lacks not only nomenclature and agreement in definition, new names assigned to cybernetic mechanisms in this report, such as, CYBERTYPE® ,[1] "Cybercom",[2] "Cybergenetics", "Cybersem", "Cyberplate", "Cyberglove", "Cyberlamp", "Cyberview", "Cyberphone", "Cybertac", "Cyberbraille", and "HAIBRL", should not alarm the reader, for they fulfill special needs of identifying new mechanisms and concepts. Their introduction also demonstrates the vast area of cybernetics yet to be explored by special educators and others in which multidisciplinary approaches can best be used to benefit mankind. In a similar manner, but in different applications, early investigators employed cybernetic principles to better understand man and his automata in warfare. [Wiener, 1948, p.11]

In this report, the term "Cybercom", is introduced by the author only to define "a system constrained to some boundary within which utilization of the principle that intelligence, feedback, regulation, stability, adaptivity, maintainability, and evolutionary programming, are essential for goal optimization." [Kafafian, 1968]

Perhaps communication channels *in*, *through*, and *out of* our neural nets (where, eventually, determination of man's behavior, sense of values, priorities, and goals for survival and effective utilization of resources are decided) should be studied more thoroughly and understood in order to quest, as McCulloch (1965), one of the principal founding fathers of the science of cybernetics, quips:

"Where is fancy bred?
Or in the heart or in the head?
How begot, how nourished?"

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[1] Reg. U. S. Pat. Off.

[2] This and subsequent terms quoted here are trade-marks of H/K Associates

METHODS

SECTION I

CYBERCOM SYSTEMS

The following descriptions cover twelve of the Cybercom systems and subsystems studied in this research program for use by educators who are principally concerned with the education of multiple-impaired children and youths. Undoubtedly, alterations will occur in techniques, mechanisms, and philosophies as we progress and learn more of the needs of both educators and the children with whom we are concerned.

1.1 CYBERTYPE®

CYBERTYPE® 14-key interfaces [Plate 2], which are programmed for dual-inputs for the operation of electric typewriters, were used in this program. Essentially, the programming of the device operates in the following manner: When two keys of the 14-key keyboard are depressed, one typed letter, symbol or function is activated on either a typewriter, visual display ("Cyberlamp"), or combinations of these and other feedback mechanisms used by the teacher. The interface and associated components translate the action of striking two keys simultaneously into activation of a solenoid in the typewriter, thereby producing a single letter, symbol or function available on the typewriter. A definition of a code to accomplish these translations is required. Derivation of such codes, or "Cybercodes", is an integral part and prerequisite of these procedures.

Other than print, the outputs may be programmed codes, light displays, braille (punctiform), perforated tape or cards, magnetic tape, sound, palpable vibrations, or combinations thereof.

It may be noted here that the physical area of many typewriter keyboards is about 36 square inches. However, the keyboard area of the 14-key keyboard used in these studies is less than 6 square inches, or approximately one-sixth the area of a typewriter keyboard. The smaller keyboard revealed significant advantages for all subjects tested, by virtue of its compact size and having 14 rather than 49 keys. But primarily, the programming technique permitted children to operate mechanisms which heretofore were unoperable by them.

The 14 keys on one of the interfaces studied are split and arranged on two sides, *i.e.*, seven keys to operate on each hand or prosthesis. With only seven keys to operate on each side, the mechanism introduces numerous simplifications in typing

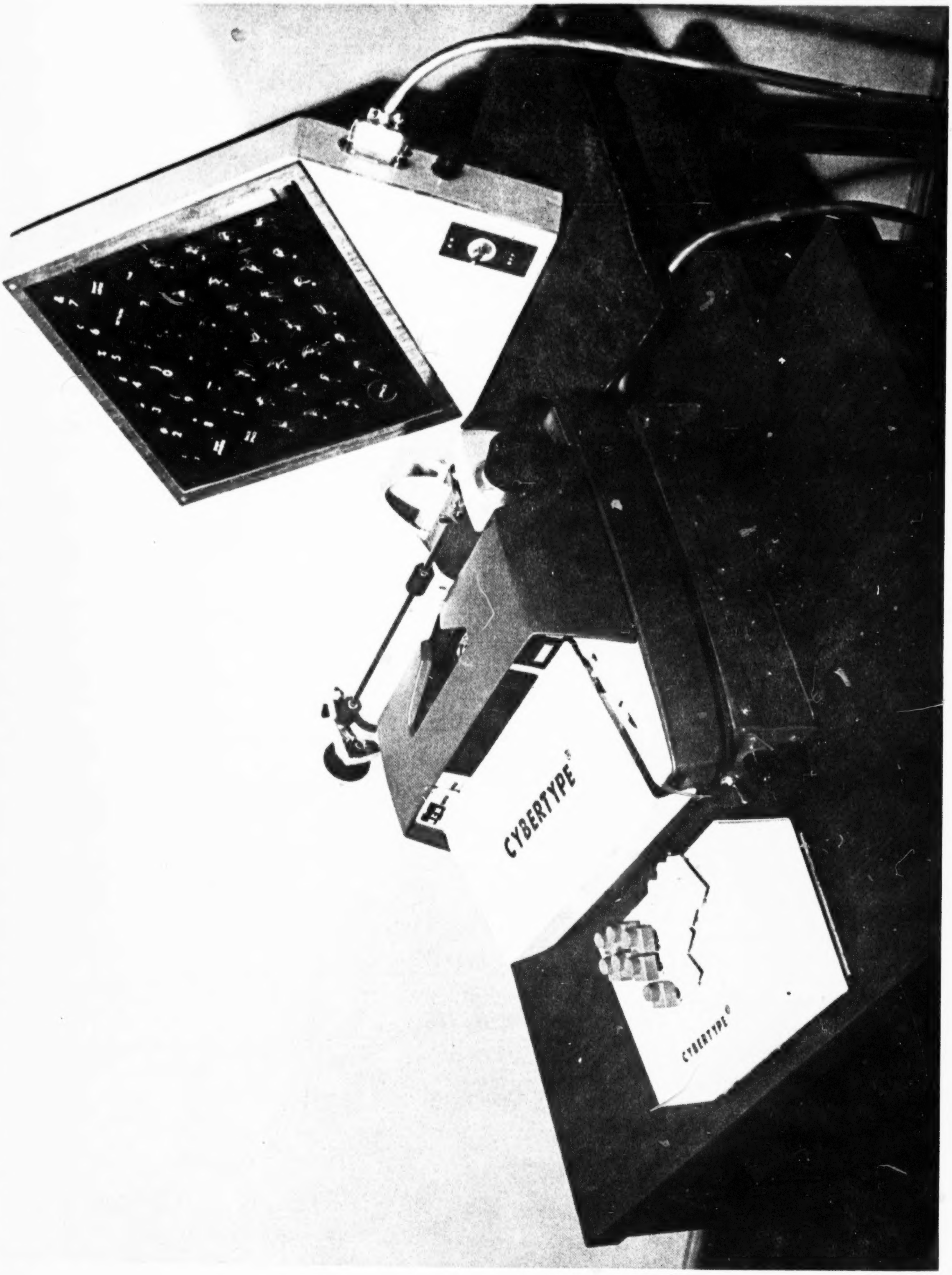

CYBERTYPE®
CYBERTYPE®

Plate 2. —CYBERTYPE® 14-key interface with "Cyberlamp," a visual display.

for the handicapped. All of the interfaces used had unmarked keys. Also, they were portable and easily moved to the position most convenient and best suited for the individual child's use. This latter aspect of a portable keyboard has yet to be fully explored.

Observations indicate that use of dual-inputs and reduction in keyboard area, along with the use of 14 rather than 49 keys, presented advantages for all of the subjects tested. This included the blind, children with motor deficiencies, the one-armed child, and the child who had neither hands nor wrists. The researchers also observed that, with the mechanisms studied:

(a) Less arm and wrist motion was required by the user.

(b) For children who use their fingers, touch-typing was "automatic" (key tops need not be labeled).

(c) The mechanisms could be operated remotely, *e.g.*, from wheelchairs, telephones.

(d) The interfaces were interchangeable and adaptable to various handicaps.

(e) The keyboard was portable and could be divided into physically separate sections.

(f) The programming codes could be changed easily for accumulation of data on different finger positions.

(g) Memorizing the dual-keying positions by subjects and investigators was not a difficult task.

(h) The portability of the keyboard was essential for many children who absolutely could not handle a standard keyboard.

In one version of coding used, the letters were arranged sequentially, according to the frequency of their usage.

1.2 PROBABILITY OF LETTER USAGE IN ENGLISH TEXT

One of the initial "Cybercodes" was based on the sequence of the frequency of letter usage in the English language as follows:

E T A O N I R S H D C L M U F P Y B G W V J K Q Z X

Subsequent literature searches revealed slight variations of this order. For example, H. S. Zim (1948) in his book, *Codes and Secret Writing*, lists the order of frequency of the letters as follows:

E T A O N R I S H D L F C M U G Y P W B V K X J Q Z

with the comment that some experts list "L" before "D", and "Q" before "X". D. D. Millikin (1943) gives the sequence:

E T A O I N S R H D L U C F M P Y G W B V K J Q X Z

Further letter frequency usage in the English language was undertaken; a sample from a page selected at random from *The Congressional Record* (1967), yielded the following sequence:

E T A I O N S R H L C D U M P F Y W G B V K J X Z Q

Subsequently, the "Basic Word List" (a component of the dual-input teaching material -- see Appendix B) revealed the following sequence:

E A O T R N I S L H C D U P M G B W F K Y V Z Q J X

These samples, however, were of minimal usefulness and validity, since the sources did not consider either frequency of word usage or the high frequency of small words, such as, "the", "of", "for", et cetera.

Even from these samples, however, it appears that there was no absolute, fixed order of letter dominance. The order chosen for the present coding, in a sense, was a composite of available data, and was generally representative of frequency of usage commonly encountered in textual materials. The major shortcoming was the lack of published data anent the frequency of all types of symbols, functions, and letters of languages other than English.

Since programming is readily changeable to other letter sequences via a converter, modification or changing of the codes might prove to be extremely revealing where the subject is suspected of having dyslexia or unique problems in identifying or controlling certain digits. The "plug-in" matrix, which is part of the converter, permits modifications of the code. [Plate 8]

Collateral investigation was undertaken into the frequency of digraphs (sometimes called bigrams), or 2-letter sequential combinations, in English, because of their significance in the design of coding. Here, again, sources yielded differing conclusions, which probably was a consequence of the different types of samples chosen (*e.g.*, spelling lists, personal letters, or other texts). Zim (1948) cited a list which he qualified as "roughly in order of use":

HE AN RE ER IN ON AT ND ST ES EN OF TE ED OR TI HI AS TO

The book, *Typewriting Behavior*, A. Dvorak, W. Dealey, *et al.*, (1936), includes the following table comparing the results of digraph counts taken from an article by H. O. Yardley (1936), "Cryptograms and their Solution", and from D. D. Lessenberry's, "Chart Showing all 2-Letter Sequences Based on an Analysis of the Horn 3,000 Commonest Words":

Digraph	TH	ER	ON	AN	RE	HE	IN	ED	ND	HA	AT
Yardley	50	40	39	38	36	33	31	30	30	26	25
Lessenberry	13	37	33	22	42	14	50	35	15	9	23

Digraph	EN	ES	OF	OR	NT	EA	TI	TO	IT	ST
Yardley	25	25	25	25	24	22	22	22	20	20
Lessenberry	31	30	2	20	22	18	26	7	16	24

Digraph	IO	LE	IS	OU	AR	AS	DE	RT	VE
Yardley	18	18	17	17	16	16	16	16	16
Lessenberry	16	21	13	14	22	10	17	9	16

Still another ranking of digraphs appeared in a patent by A. Dvorak, *et al.* (1936) [Pat. No. 2,040,248: Typewriter Keyboard], on a simplified keyboard arrangement. After completing an analysis of the standard typewriter keyboard in relation to the capabilities of the average typist, Dvorak and Dealey based their work on the premise that:

> "With a person who has in any appreciable degree mastered this spacial pattern, typewriting proceeds in unified sequences or overlapping key-strokes identified as words and phrases. Words are stroked as wholes, and the typist is usually unaware of the individual letters. Successful typing is the more or less relaxed following, by the typist, of such sequences (word patterns) with the typewriter. A keyboard arrangement must be based upon the requirements of the sequential stroking, the even, uninterrupted flow of which we can designate 'rhythm'."

In order to develop this rhythm, the designers arranged the keyboard in a manner which would place the maximum number of the most frequently used letter-sequences so that one of the letters appears on one side and the succeeding letter appears on the opposite side, thereby alternating the use of each hand. Anticipation of fingers is accelerated. Initially, they analyzed key-letter configurations, of the standard keyboard, which tended to slow typing speed.

> " ... measurements show these unavoidable delays increase as the special arrangements change from (1) a sequence in the same bank involving fingers of opposite hands, to (2) a sequence located in upper and lower banks yet still involving fingers of opposite hands, to (3) a sequence involving adjacent fingers of the same hand, to (4) a sequence located in upper and lower banks and involving fingers of the same hand, to (5) a sequence employing the same finger." [A. Dvorak, *et al*, *supra*]

This research has considerable value to the designer of dual-fingering keyboards. However, the dual-input CYBERTYPE® requires the simultaneous use of two fingers, one from each hand, or two fingers from one hand. The anticipation of the next letter keying combination presents different considerations yet to be defined. Never-the-less, this early work clearly portrays the lack of consideration of the appropriate human engineering of typewriter keyboards. We intend to conduct analogous analyses to produce a code maximally easy to learn and maximally efficient; the smoother the final arrangement, the longer the student, particularly if handicapped, might operate the keyboard without tiring rapidly. The result of such studies will initiate the rearrangement of the dual code in terms of digraph frequencies and should provide numerous challenging projects.

Dvorak and Dealey expressed findings which indicate the importance of these letter sequences, namely:

> "That 11 digraphs or two-letter combinations make up 25% of the usage of the millions of digraphs counted;
> "That 34 digraphs make up 50%;
> "That 57 digraphs make up 75%:
> "That 137 digraphs make up 90%;
> "That 22 trigraphs or three-letter combinations make up 25%;
> "That 104 trigraphs make up 50%;
> "That 46 four-letter combinations make up 25%;
> "That 208 four-letter combinations make up 50%." [A. Dvorak, *et al.*, *supra*]

J. R. Pierce (1968), in his article, "Information Theory", Bell Laboratories Record, uses the following probability of letter usage in English text:

Letter	*Probability of Use in English Text*	*Letter*	*Probability of Use in English Text*
SPACE	.1859		
E	.1031	F	.0208
T	.0796	M	.0198
A	.0642	W	.0175
O	.0632	Y	.0164
I	.0575	G	.0152
N	.0574	P	.0152
S	.0514	B	.0127
R	.0484	V	.0083
H	.0467	K	.0049
L	.0321	X	.0013
D	.0317	J	.0008
U	.0228	Q	.0008
C	.0218	Z	.0005

Even if standard English typewriter keyboards were improved and modified (and previous researches[1] have demonstrated gross advantages based on sound scientific principles which prove beyond any reasonable doubt the advantages of other keyboard arrangements), there remains the fact that certain individuals with various types of disabilities still would be unable to use standard keyboards, irrespective of where the letters were physically located. This conclusion is supported by subjects tested in this program, who, heretofore, were unable to utilize a standard electric typewriter keyboard effectively and did, indeed, operate 14-key interfaces.

[1] A. Dvorak, *et al.*

1.3 SPLIT-INTERFACE KEYBOARD

Separate sectional keyboards (right side and left side banks or upper and lower) were employed in one version of the mechanism. [Plate 3] In one of the trials, the two halves, with seven keys each, were clipped to each arm of a wheelchair. They also could be placed on either side of a bed or other accommodation so that individuals may type and/or operate other devices while in a reclining position.

1.4 ONE-HAND KEYBOARD

One subject, who had the use of only one hand, was taught to use a small 14-key keyboard. [Plate 4] The area of the compact keyboard was about four square inches.

The student achieved a speed of ten words-per-minute after about seven hours of instruction. This rate was not comparable to her regular typing capability, where she demonstrated a speed of five words-per-minute on a standard electric typewriter. A second candidate who operated the compact interface successfully is under medical treatment at the present time and not available as a subject.

Although only eleven keys are required for a one-hand, dual-input interface to activate 92 functions of one model of a CYBERTYPE® , the 14-key keyboards were used in the one-hand typing experiments because they were readily available along with instructional materials.

1.5 "CYBERSEM"

The "Cybersem" interface is for the handicapped individual who does not have any fingers, is blind, and cannot readily be taught to write or read braille. [Plate 5] By use of two parts of the person's body, or through the use of prostheses, typing is accomplished in a "semaphore-like" manner, *i.e.*, ordinarily, two collateral, appropriate movements of arms, fingers, prostheses, or other parts of the body, produce a specific letter, symbol or function; it is not necessary, with all types of interfaces, that the two movements take place simultaneously, just as long as the transducers are activated together at one point of the keying period. Other styles of interfaces, in which time delays are built, are used in special applications. In the "Cybersem" interface that is being studied, two multiposition levers are guided by the person's prostheses to appropriate contacts located within the "Cybersem" mechanism.

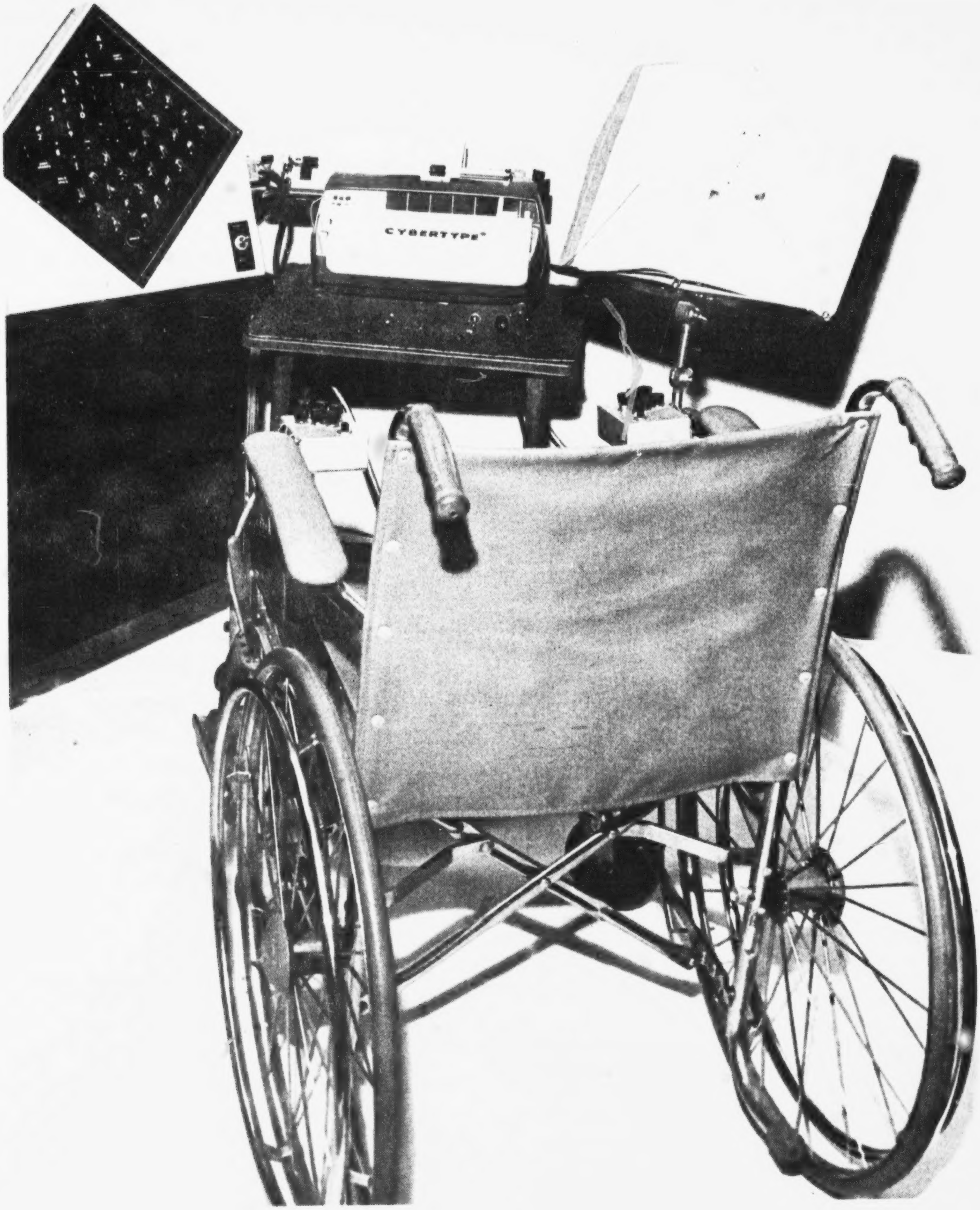


Plate 3. —Split-Interface keyboard mounted on the arms of a wheelchair. A "Cyberlamp" is shown to the left of the CYBERTYPE®.

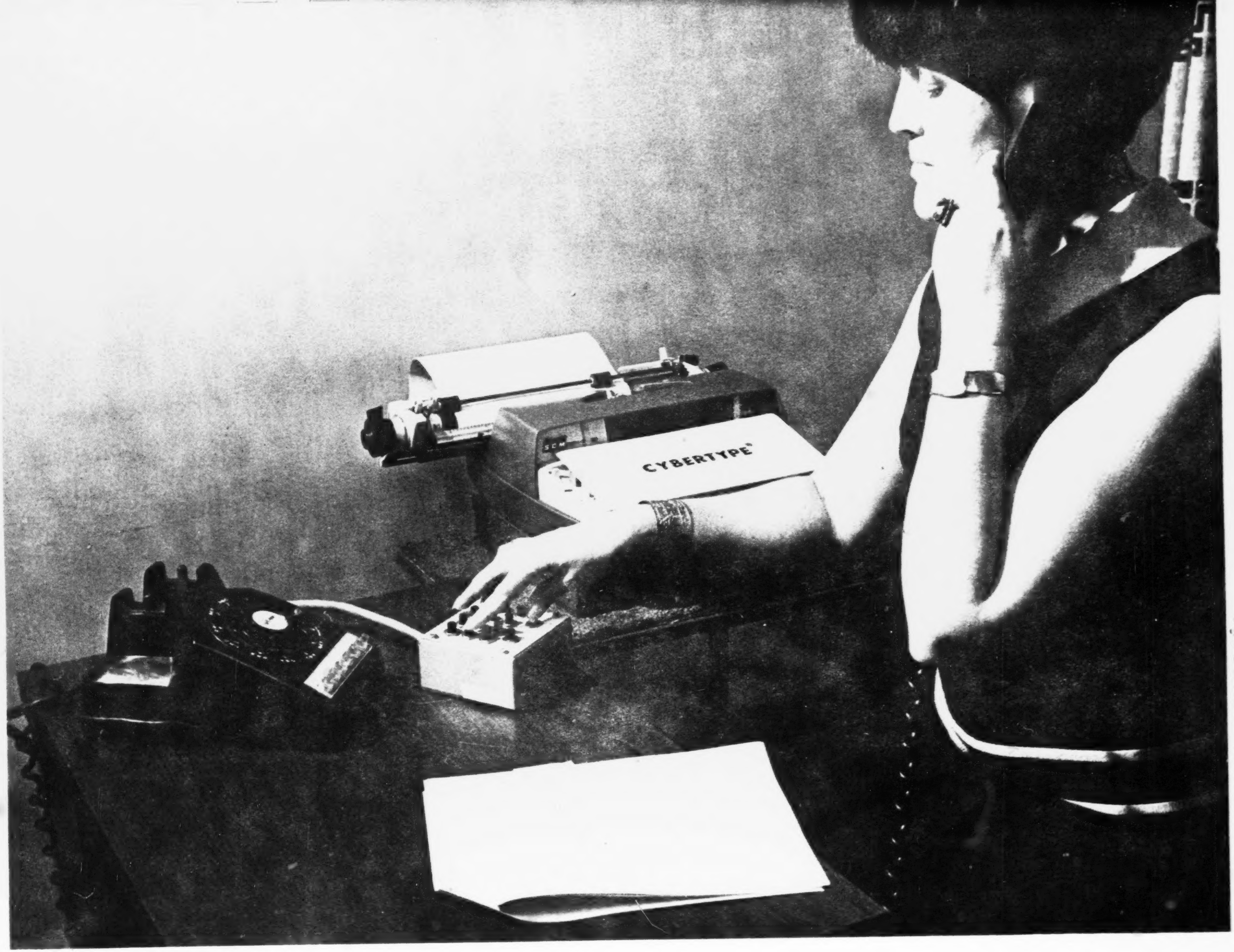


Plate 4. —CYBERTYPE® 14-key, one-hand interface shown in use while receiving dictation over a telephone.

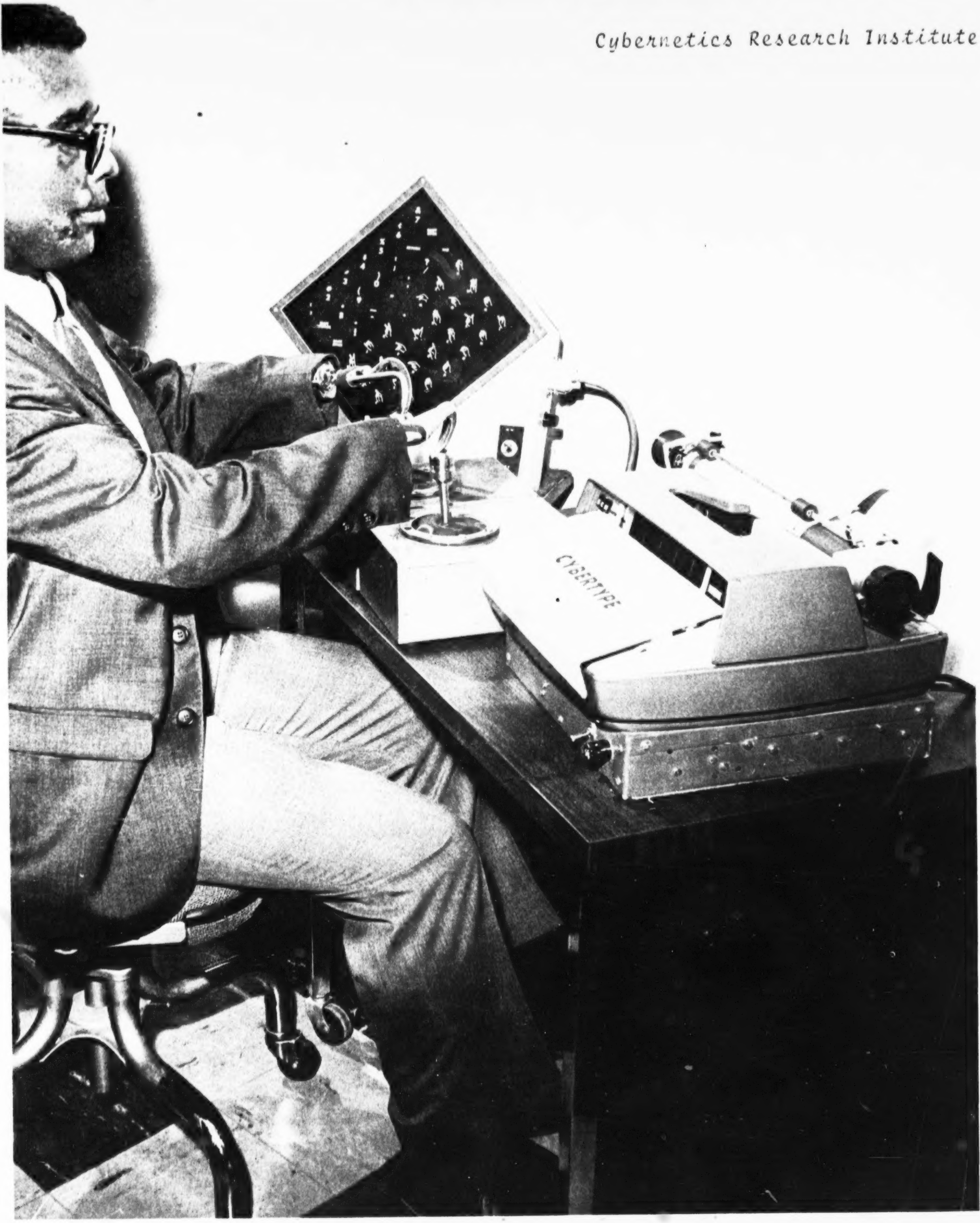


Plate 5. —Instructor with monocular vision and two prostheses operating the CYBERTYPE® and the "Cyberlamp," with the "Cybersem" interface.

This mechanism is in the process of being evaluated by the investigators and one bilateral amputee who has monocular vision. A soldier who is now a bilateral amputee and has a total loss of vision in both eyes is being approached in order to learn whether he is in a position to participate in the testing program.

1.6 "CYBERPLATE"

The keyless typewriter "keyboard" studied incorporates an interface which consists of a conductive plate called "Cyberplate". [Plate 6] It receives dual-input programming from appropriate transducers, seven of which are attached to each hand of the subject. Three fingers of each hand carry two transducers each: one for a "flat-keying" position and one for a "tip-keying" position. The flat-keying positions correspond to the upper keybank on the 14-key interface, and the tip-keying positions correspond to the lower keybank. Each thumb carries only one transducer, which corresponds to the "thumb key" on the 14-key interface. The mechanism's potential has not fully been explored at this stage of the project.

For blind children, this keyless configuration appears to be particularly suitable since contact can be made anywhere on the "Cyberplate" surface through use of transducers worn on the tips of the child's fingers; the child does not have to depress keys. Blind children and the investigators have used the keyless configuration only in limited applications.

1.7 "CYBERGLOVE"

One configuration of "Cyberglove" is fitted with transducers to make contact with the "Cyberplate". Its transducers are connected via flexible cable to the CYBERTYPE® . By making contact with the appropriate "flat", "tip" or "thumb" contacts (one from each hand) to the "Cyberplate", a corresponding typewriter key becomes operational. In other versions of the "Cyberglove", both elements of the transducers are contained in the gloves, thereby precluding use of the "Cyberplate". The operator may use a portion of the glove or other surface to activate transducers contained in the glove. [Plate 7]

Of significance is the keying "standardization" used throughout the initial phase of this work. For example, once the subject has learned the dual-fingering on the "Cyberplate" and "Cyberglove", he can, without changing the code or learning other codes, quickly adapt himself to the 14-key interface.

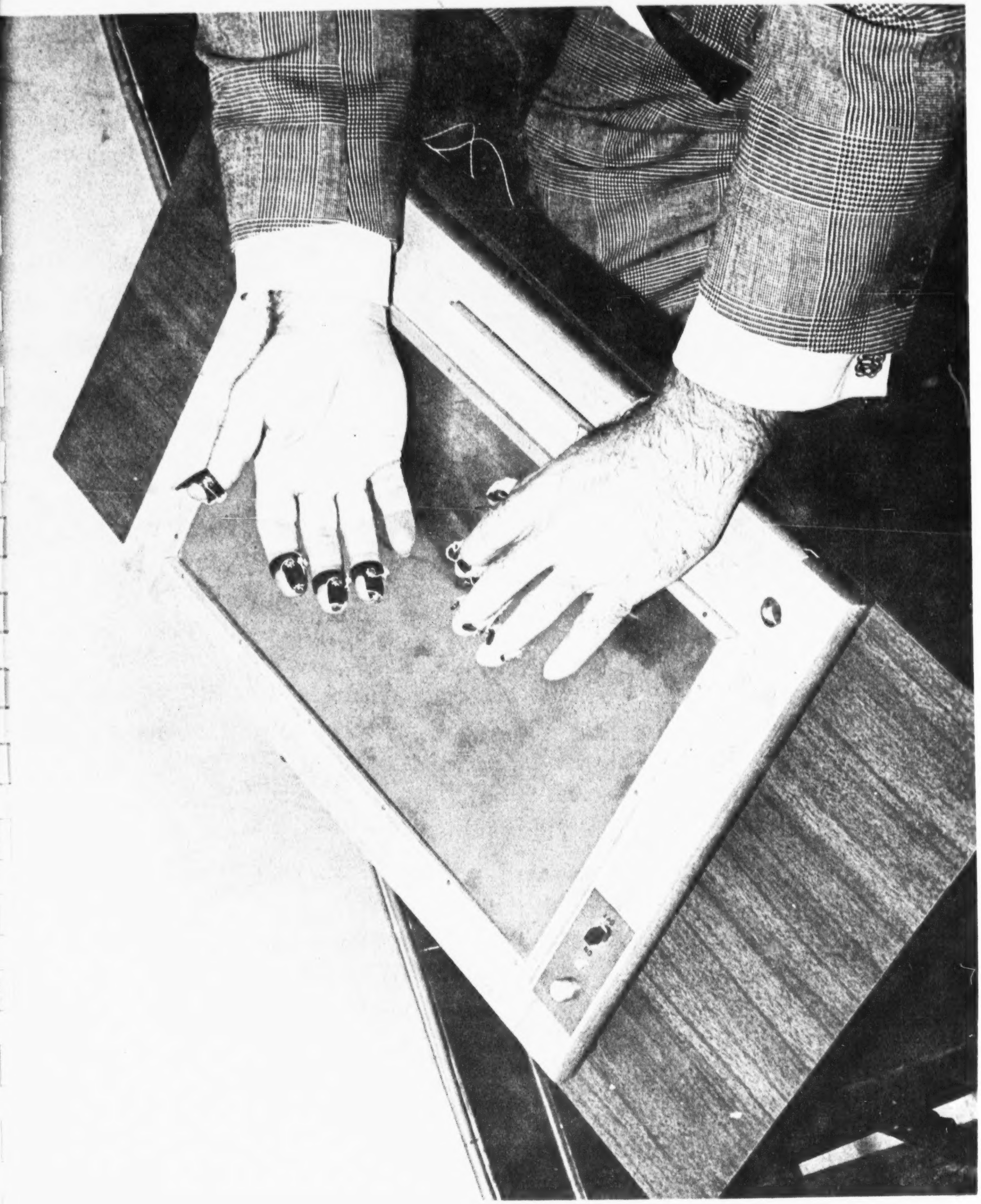


Plate 6. —The keyless "Cyberplate."

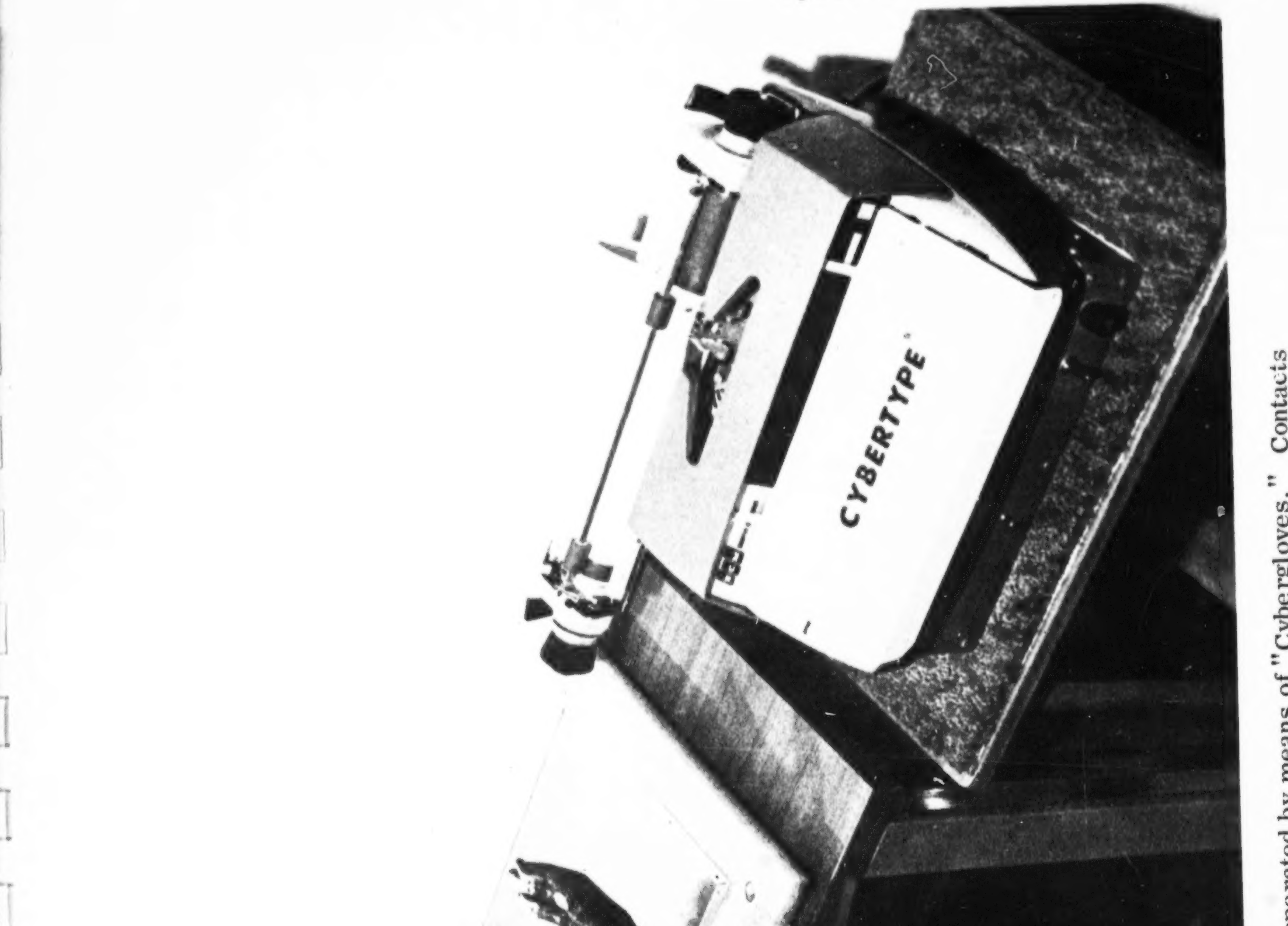


Plate 7. —Keyless typewriter operated by means of "Cybergloves." Contacts can be made on any part of the "Cyberplate" to obtain the function, letter, or symbol desired.

1.8 "CYBERLAMP"

"Cyberlamp" [Plate 8], an alphanumeric and manual alphabet visual feedback device, consists of 49 lamps (transparent templates) which display the appropriate letters, symbols or functions as they are programmed. Three sizes are being tested: 49 square inches, 70 square inches, and 100 square inches in area.

Tests are underway with two deaf subjects, who are learning how to operate these mechanisms. One subject averaged a reading capability of 15 words-per-minute during her second lesson.

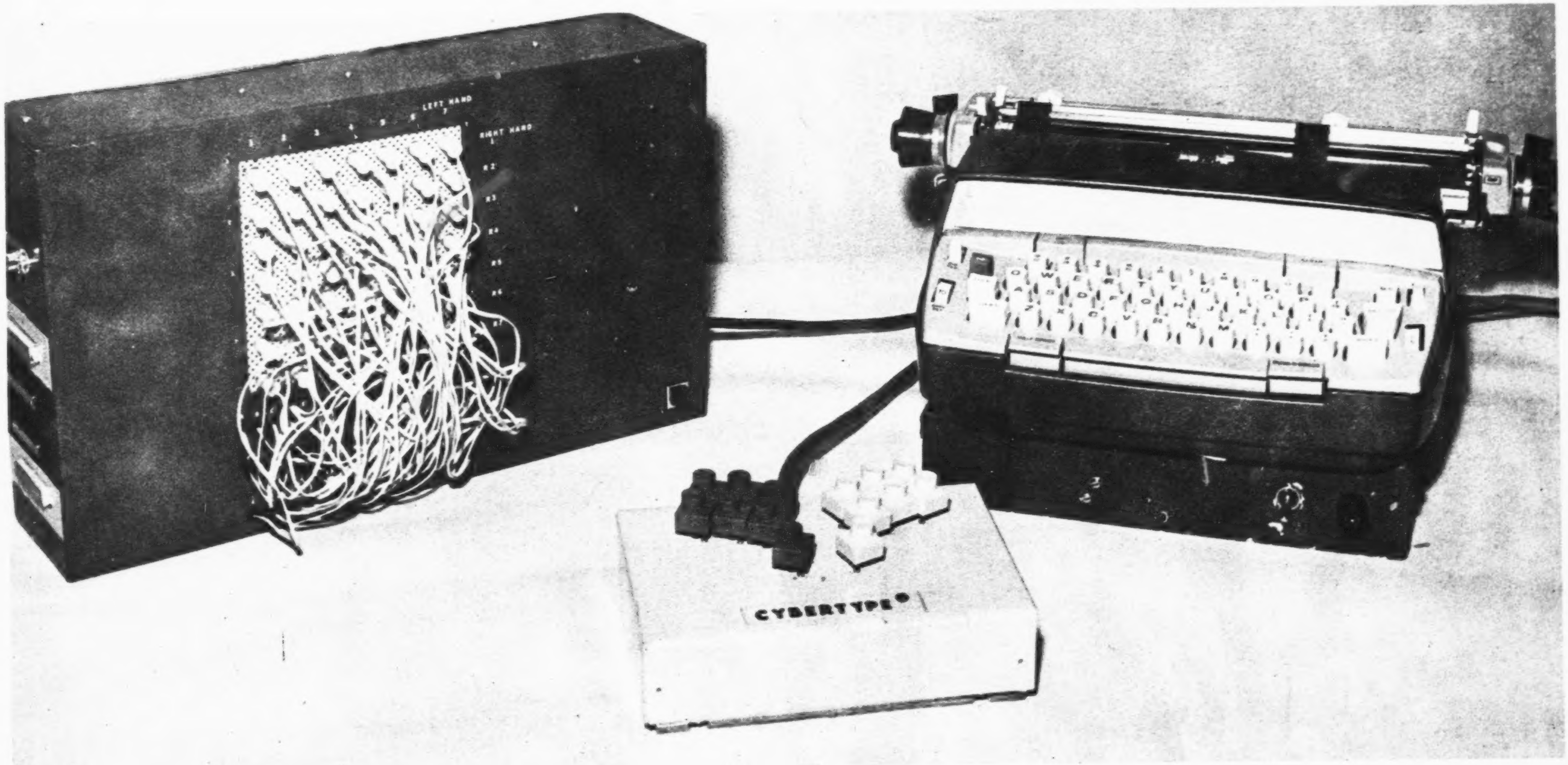
1.9 "CYBERVIEW"

"Cyberview" is a visual feedback mechanism used in the system. A fiber optic bundle is used to receive visual information from the printed page of the typewriter, or from other printed material, and provides feedback of the intelligence as it is typed. For example, the most recently typed letters are seen immediately by the typist. The viewer, without moving, is able to see what he has typed without moving or changing his position. Visual feedback is important to the beginner. It reduces hesitation following each typed letter. The subject's observations seek confirmation that the letter typed is "for real". With handicapped children, some of whom may use wheelchairs and, thus, may be remote from the typewriter, the requisite body movements may be difficult. Observations revealed that the teacher, in many instances, was compelled to remove the paper from the typewriter platen to reassure the student that "something is happening." It is hoped that experiments with the "Cyberview" will lead to a better understanding and utility of feedback for handicapped children.

1.10 "CYBERPHONE"

The "Cyberphone" [Plate 9] is a mechanism used in the study which permits the deaf and individuals with speech impediments to communicate *via* telephones. Standard telephone lines are used. This obviates the necessity of adding costly connections to the telephone system or leasing lines. "Cyberphone" uses auditory coupling with a standard telephone instrument, a 14-key interface, a "Cyberlamp", and a coding and decoding mechanism, all of which are contained in a portable carrying case.

"Cyberphone" is a Cybercom system which allows information


LEFT HAND
RIGHT HAND
CYBERTYPE®

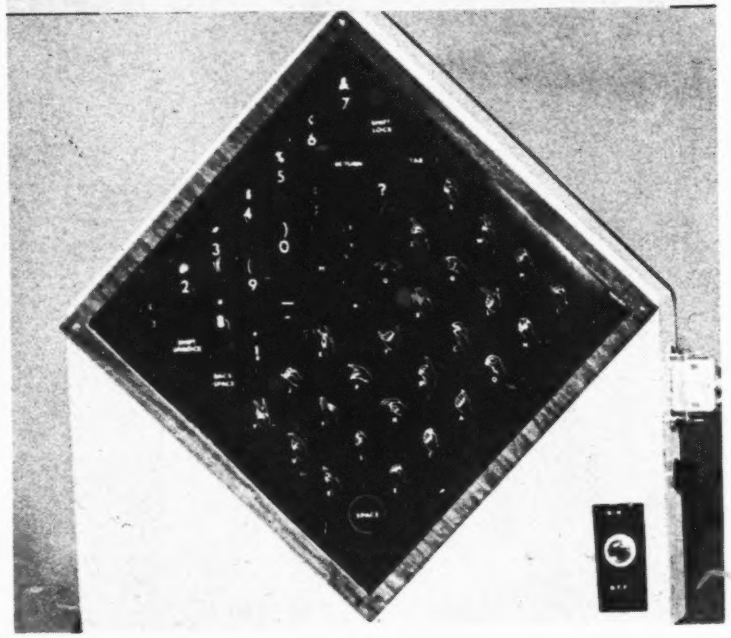


Plate 8.

CYBERTYPE® (shown above) with a converter (left background) and 14-key interface (foreground).

"Cyberlamp"—a visual display (lower left), which provides feedback to sighted persons who are deaf and/or have speech impediments.

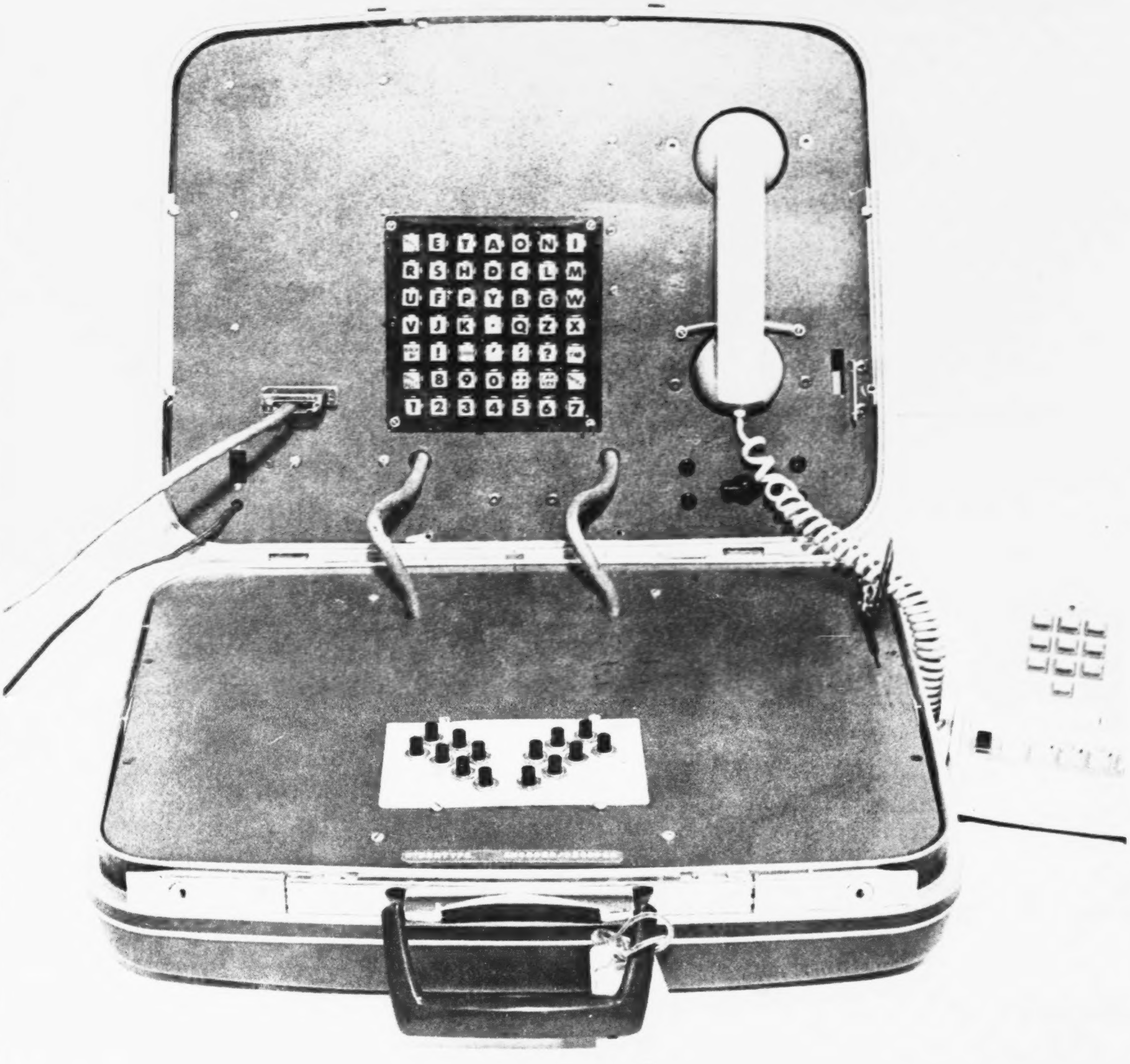

E T A O N I
R S H D C L M
U F P Y B G W
V J K Q Z X
8 9 0
1 2 3 4 5 6 7

Plate 9. —"Cyberphone"— a portable telephonic communications device for use by the deaf and persons with speech impediments.

that is typed to immediately appear (neglecting transmission delays of the telephone system) at the receiver. The receiver may be equipped with a portable "Cyberphone" and/or "Cyberlamp". The sender types the message on an appropriate interface. By using a dual-input "Cybercode", the mechanism transmits desired information. A translator converts the transmitted information into appropriate signals which are transmitted *via* the telephone system to the receiver. The "Cyberphone", which is in a receiving mode, decodes the coded signals and converts the signals that are acceptable to the CYBERTYPE® printing mechanisms, which portrays the message, complete with punctuation and programmed spacing. A miniature (49 square-inch) "Cyberlamp" also is contained in the "Cyberphone" carrying case for means of displaying either the usual typewriter functions or the manual alphabet. It can be used without the typing mechanism.

In one test, a low cost tape recorder was used to record the Cybercoded signals. Subsequently, the recorded signals were played back into another "Cyberphone". The transmitted message was viewed on the light display and was recorded permanently *via* a CYBERTYPE® print-out.

1.11 "CYBERTAC"

This mechanism, at the time of this report, was not tested formally with subjects. Essentially, it delivers dual palpable vibrations to the recipient's hand or to other parts of the body from dual-input Cybercoded interface. Each dual-input corresponds to a single function, be it letter, word, sentence, or other information previously established between the sender and receiver. Instructional material has not been developed. The investigators have been the only subjects thus far. The initial experiments indicate that the dual-input palpable vibrations to the fingers, as derived from the CYBERTYPE® output or from signals stored in cassettes, appear to offer a means of effectively communicating with people who have serious visual impairments and who have difficulty reading braille. Through use of the very same dual-code and interface mechanisms used to operate either punctiform or typewriters equipped with 14-key interfaces, a whole new area of investigation lies ahead.

1.12 "CYBERBRAILLER"

Two mechanisms were studied in conjunction with a commercial electric braille typewriter and a standard electric typewriter. Both typewriters were activated simultaneously by the 14-key

CYBERTYPE® interface. The two print-outs achieved are braille and standard type. Thus, continuous proofreading of braille by a sighted person untrained as a braillist is possible in an economic manner.

One experiment was to ascertain the feasibility of simultaneously producing braille and ink print as obtained from a standard electric typewriter. In this instance, the interface used was a 14-key CYBERTYPE® keyboard. It was demonstrated that, even though a subject could not read braille, she was capable of proofreading the braille output by viewing the typewritten pages on a standard electric typewriter adjacent to the electric braille machine. One disadvantage envisioned is that the upper case symbols on the standard typewriter keyboard are different from the symbolism of the upper case braille keyboard. For proofreading, this can be resolved in one manner by modifying the upper case of a standard electric typewriter to correspond to the very same letters and symbols as contained on the electric braillers. However, costs to modify only two electric typewriters were prohibitive, and it would not be prudent, for the purposes of this study, to pursue this approach at the present time. The fact that the print-out of the braille typewriter upper case position can be checked easily and quickly by comparing it to the equivalent upper case typewriter print-out, clearly demonstrated the proofreading advantages without requiring the typist to be a braillist.

The commercially available electric brailler which was used may find wide application, depending upon its acceptability of the coding of the keyboard and the extent of its compatibility to computer systems. [Plates 10 and 11]

The Woodcock Electric Brailler system (Woodcock, 1965) [Plate 12], although not commercially available, consists of a typewriter keyboard (modified to accept Braille 2 symbology) and an automated braille-writer. It appears to have numerous advantages because of its computer compatibility. In any event, CYBERTYPE® can be used with either electric brailling system.

In the two models that were tested during the program, it was demonstrated that a braillist could be quickly trained (about ten hours) to operate the CYBERTYPE® , thereby eliminating the requirement to learn braille solely for the purpose of proofreading.

Furthermore, the fact that a simultaneous visual output in the form of ink print and tactual print form output may offer desirable advantages heretofore unobtainable to organizations who specialize in the preparation of braille documents.

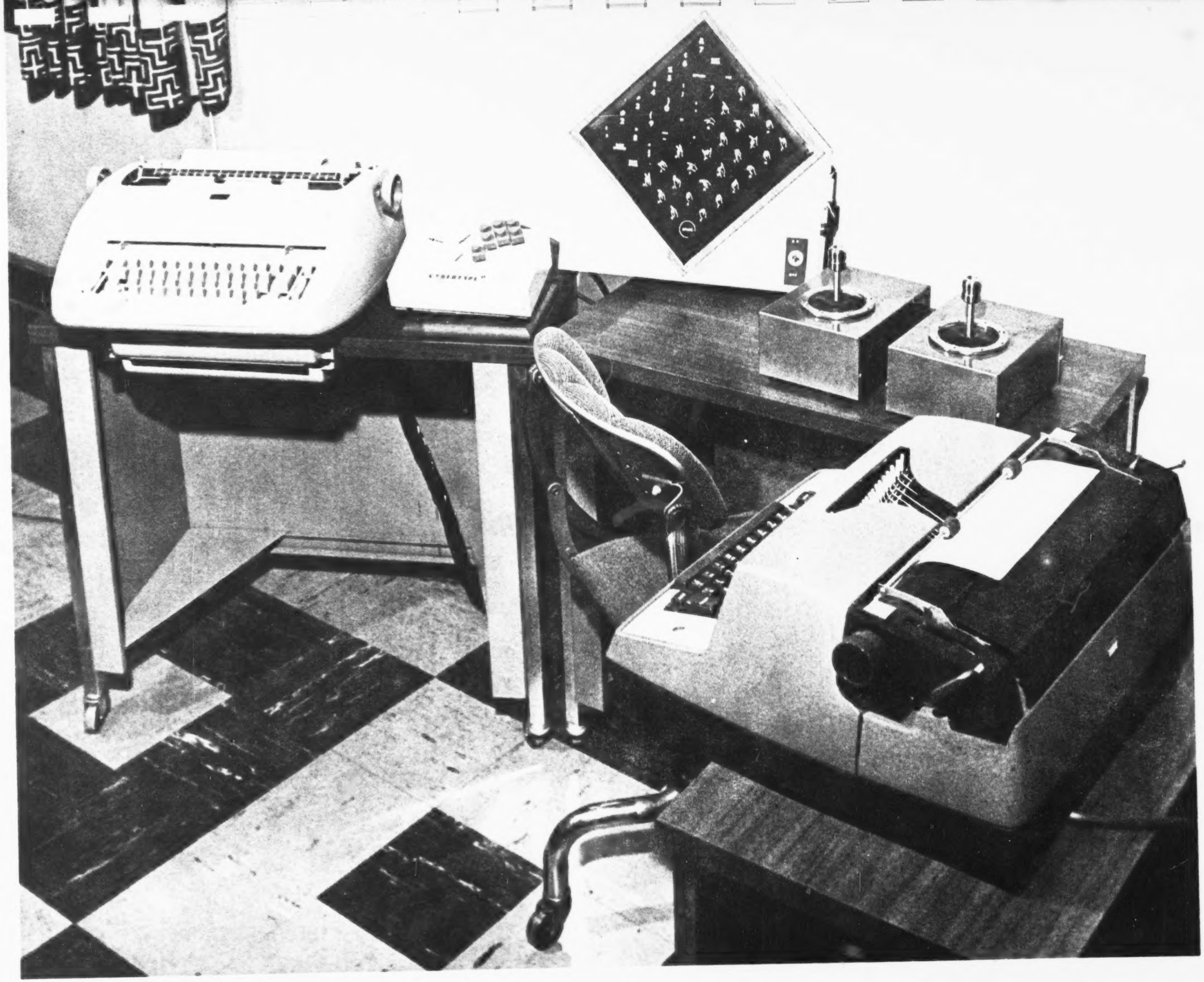


Plate 10. —"Cyberbrailler," with a CYBERTYPE® 14-key interface and a "Cybersem" interface. In the background, a manual alphabet and alphanumeric display "Cyberlamp" is shown for use by sighted braillists.

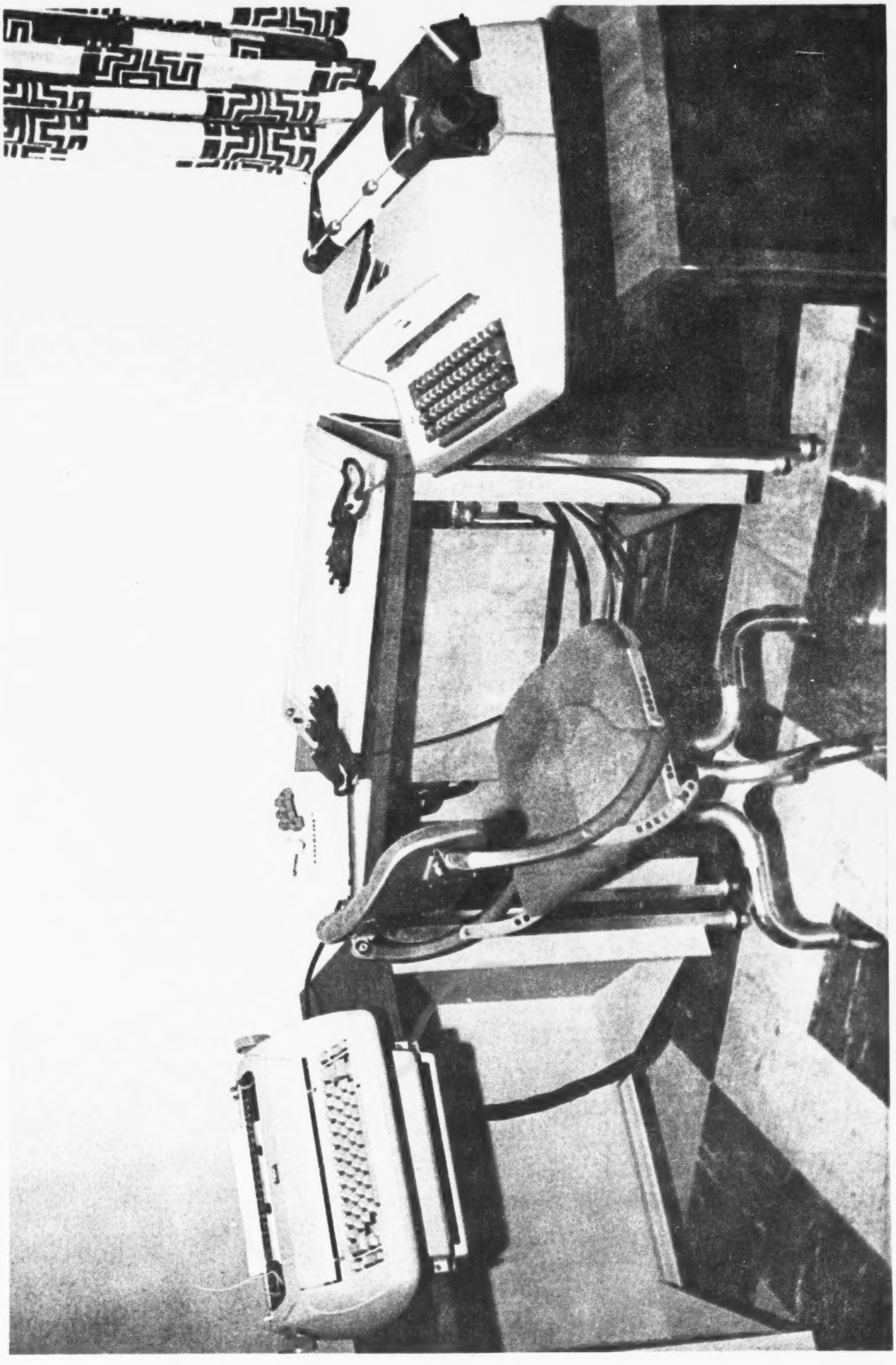


Plate 11.—"Cyberbrailler," showing commercially-available typewriters used in conjunction with a 14-key CYBERTYPE interface and a "Cyberglove-Cyberplate" interface. Simultaneous brailler and typewritten outputs are available.

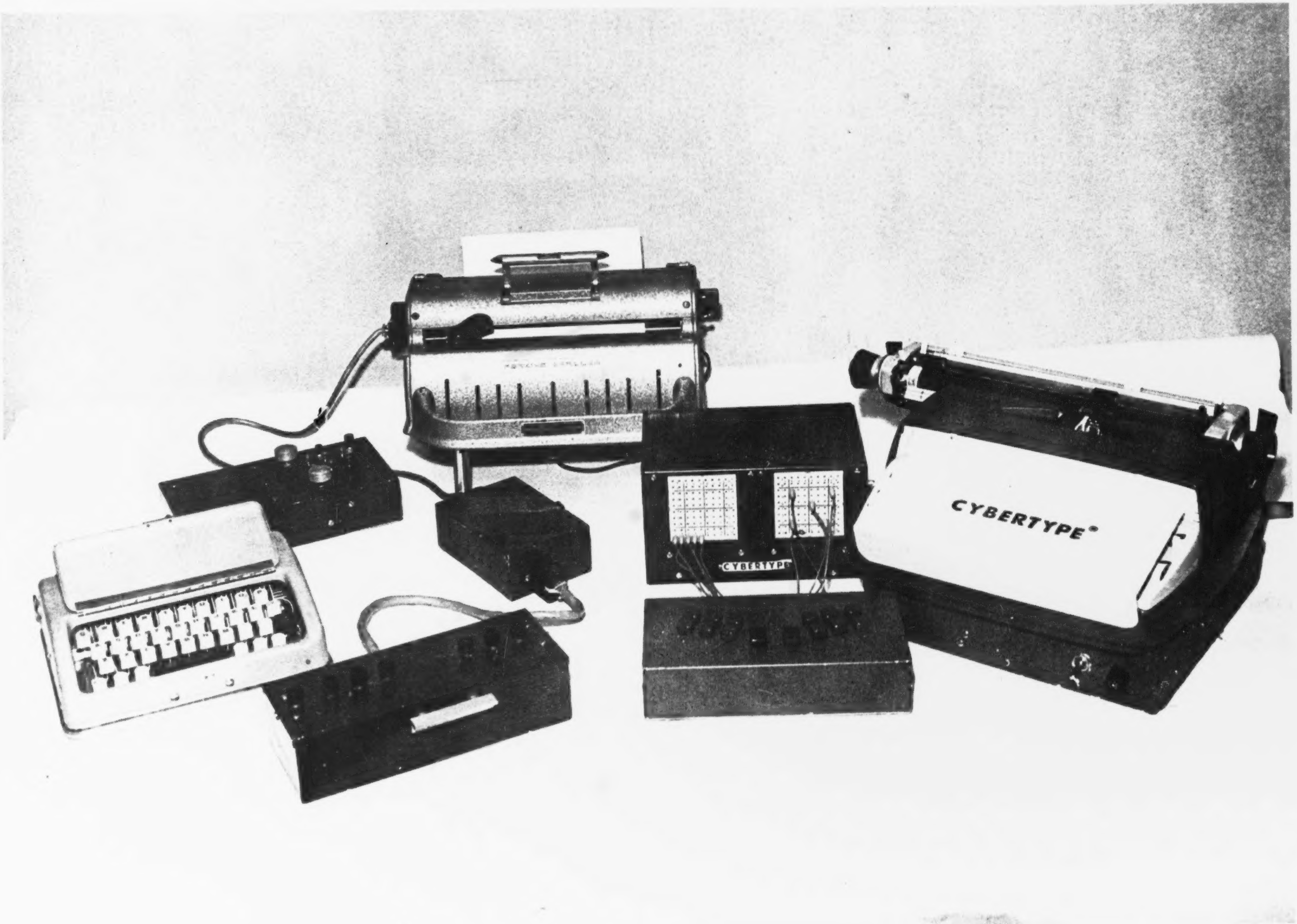


Plate 12. —Woodcock electric brailler (shown at left); CYBERTYPE® 14-key interface (shown at right) with a converter, which permits changing of the codes. Both braille and typewritten outputs are available simultaneously.

1.13 HAIBRL

HAIBRL is an experimental tactual communications system proposed by the principal investigator. It appears, from an analytical viewpoint, to have numerous merits. Essentially, HAIBRL is a puntiform communications system requiring not more than two dots and a "guidance" bar in every cell, for 136 functions. The concept is based on elementary combinatorial principles and a newly introduced technique to the punctiform art, namely, a spatial reference for each cell. One assumption on which HAIBRL is based is that fewer dots per cell,* when used with a reference perforation, may yield easier tactual learning and reading as compared to the presently used multi-dots per function and constant references to adjacent cells in addition to an understanding of the context of the materials.

The organization of HAIBRL is accomplished by arranging the coding around a raised horizontal or vertical perforation, which may appear in the center of the cell. Each bar identifies a new cell. Quadrants encompass the reference perforation and each contains four dot positions. Thus, with 16 positions for dots and one reference bar, up to 120 unambiguous dual-dot patterns are available without reference to adjacent cells. Compare this to the 63 patterns (Ashcroft, 1963) with the braille system, of which a total of 31 patterns are individually ambiguous, whereas, 120 dual-dot unambiguous combinations are available in the HAIBRL cell. Thus, a total of 136 single- and dual-dot discrete patterns can be obtained with the HAIBRL cell (there are 16 single-dot functions in each cell). A rotation of the reference perforation through 90° would yield an additional 136 functions, thereby providing 272 functions.

With HAIBRL, the patterns and, hence, the functions, can be increased without ambiguities. For example, three-dot HAIBRL yields, in addition to the 136 functions, 560 additional unambiguous functions, thus extending the system to 696 discrete functions. [Tables II & III, Appendix G] Refer to Chart 1 for dot combinations.

The gross ambiguities which appear in the cell introduced by Louis Braille are shown in Table I.

Since the Louis Braille cell, which contains 63 configurations, has 31 patterns which are ambiguous, approximately 50% of the symbols are absolutely confusing. To beginners and experts alike, when individually presented, this is one shortcoming. The difficulties overcome by students required to learn how to write in reverse before they can communicate effectively; and their ability to learn, at the very same time, multiple meanings of an already ambiguous pattern, clearly demonstrates the remarkable capabilities of braille readers and should remind us of the

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* Nolan, Morris, Kederis, and Fieg (1964)

Totals	Dots in Cell	Dot Combinations															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
63	6	6	15	20	15	6	1										
127	7	7	21	35	35	21	7	1									
255	8	8	28	56	70	56	28	8	1								
511	9	9	36	84	126	126	84	36	9	1							
1,023	10	10	45	120	210	252	210	120	45	10	1						
2,047	11	11	55	165 ~~105~~	330	462	462	330	165	55	11	1					
4,095	12	12	66	220	495	792	924	792	495	220	66	12	1				
8,191	13	13	78	286	715	1,287	1,716	1,716	1,287	715	286	78	13	1			
16,383	14	14	91	364	1,001	2,002	3,003	3,432	3,003	2,002	1,001	364	91	14	1		
32,767	15	15	105	455	1,365	3,003	5,005	6,435	6,435	5,005	3,003	1,365	455	105	15	1	
65,535	16	16	120	560	1,820	4,368	8,008	11,440	12,870	11,440	8,008	4,368	1,820	560	120	16	1

SINGLE, DUAL AND MULTIPLE DOT COMBINATIONS

Chart 1

recognition due any person who comprehensively uses braille. Fortunately, there may be added hopes for innovative systems which are less difficult. One approach might be through use of forward-writing braille mechanisms, which appear to have potential merit. One style of forward-writing slate is being designed for use with HAIBRL, in order to ascertain to what extent these new techniques can reduce the complexities of tactile communications systems.

Table I - POSSIBLE AMBIGUITIES IN THE SIX-DOT BRAILLE CELL

Dot Combinations	*Possible Ambiguities*	*Single-Dot or Dot Combinations which Yield Similar Patterns*
Single	6	1-2-3-4-5-6
Dual	13	1,2 1,4 1,5 4,2 1,3 2,3 2,5 2,6 5,3 4,6 4,5 3,6 5,6
Triple	10	1,4,5 4,5,2 5,2,1 2,1,4 1,2,3 2,5,6 5,6,3 6,3,2 3,2,5 4,5,6
Quadruple	2	1,4,2,5 2,5,3,6
Total: 31 (of a total of 63 possible combinations)		

The introduction and implementation of an innovative system, irrespective of its merits, usually present difficulties. One evolutionary approach which can be considered, is the introduction of the HAIBRL reference perforation to the present six-dot braille cell. The next step might be to add four more dot positions. Thus, with 10 dots and using a dual-dot code (no more than two dots per function), 45 two-dot functions can be obtained, along with 10 single-dot functions, or, a total of 55 functions. Subsequently, introduction of two additional dots could take place, which then would yield a total of 66 dual-dot functions plus the 12 additional single-dot functions, or, a total of 78 functions. Subsequent to this, four additional dot positions would be introduced, thereby completing the HAIBRL cell with its sixteen dot positions. The completed HAIBRL cell, when used with a dual-dot code, would provide 120 dot functions and 16 single-dot functions, or, a total of 136 functions with no ambiguities.

Initially, HAIBRL may be applied to map reading and to other documents which are to be handled by people with visual impairments. The use of reference perforation and an unambiguous code appears to present somewhat exciting applications.

We might consider visually-impaired individuals as falling into three categories or periods of life, where: (1) The child has visual impairments as an infant or is congenitally blind and has never learned to read or write; (2) a child or adult who has vision and is in the process of learning to read and write and, subsequently, *i.e.*, during the learning process, has total loss of vision, and (3) the individual who, after learning to read and write proficiently, becomes blind through accident, or natural malfunction of the visual system.

To better fulfill the communication needs of the first category, the congenitally blind, as contrasted with individuals falling into either of the latter two categories, *supra*, it is also urged by the investigator that serious reflections be considered for a language which uses phonetic characters. With one proposed system, *i.e.*, where the HAIRBL cell's pattern (in addition to representing a written letter, symbol, or function) may easily serve to represent an audible sound: those very sounds of the audible language, that have meaning.

Thus, a family of phonemes, graphically represented by a uniquely discernable and understood set of tactile symbols, which conveniently may be adapted to HAIBRL, might express adequately in tactile 'writing' any appropriate language used for communicating. Importantly, then, HAIBRL, in addition to its potential universal character as a tactile communication means, may be adapted to a phonetic alphabet, and has the potential advantage of offering the blind a communications system which would permit them to readily learn new languages, which cannot be easily achieved via braille symbology.

Recently, anthropologist, Margaret Mead (1968), proposed that the Armenian language, which uses phonetic characters, be considered as a world-wide second language. The use of Armenian phonemes together with, among others, symbology representing the 'W' sound as in 'what', the 'TH' as in 'those', the 'TH' as in 'both'; appears to offer even more advantages for blind persons. Namely, a new punctiform symbology, representing individual sounds, could be used in place of letters, many of which have numerous pronunciations. In the proposed system for the blind, "punctiform sounds" would be used in place of letters; hence, blind readers could tactually convey "puntiform sounds" directly into meaning.

CYBERNETICS RESEARCH INSTITUTE investigators are following related research, such as the U.S.O.E., B.E.H.-sponsored study of three approaches to teaching reading in braille (Harley and Rawls, in press), including a braille version of "ita" and the potential utility of Armenian phonetics for any language usage. In the opinion of the investigator, it is not fair to demand congenitally blind persons, or persons who partially know the graphic languages, to be compelled to learn a language of confusing contextual and visual pattern structures. Where audible and cutaneous senses are the principal sensory means for communications for blind persons, our present-day systems leave a great deal to be desired. Would it not then be desirable to better understand the graphene-phoneme correspondence in their written, auditory, and tactile, representations?

As for sighted persons who subsequently lose vision, there may be other problems. The shortcomings of most languages were portrayed admirably by George Bernard Shaw who, in his testamentary document, sought implementation of a simple language for all mankind. Shaw, among others, advocated a universal language for use in a world with about 2,800 languages at its disposal.

One objective of a universal language, that can be used by the blind and others, would be that it should be viable and easily learned.

In addition to a universal language, development of a worldwide sign language, one that could be used by travelers whether handicapped or not, might be considered by future educators. "Cybertalk" is a possible candidate for this demanding requirement.

With the advent of special education research programs, directed to aid multiple-impaired children, even greater by-products of significant impact may ensue.

One area of research which presents a fertile field for educational research is pictorial pattern analysis (Rosenfeld, Pfaltz, and Kafafian, 1967). The development of algorithms for computing various functions on a digital picture is a reality. The conversion and presentation of this kind of information to the neural net of a blind student should be investigated.

1.14 MODULATED RADIO-FREQUENCY GENERATOR

A modulated radio-frequency generator was modified for experimental use with deaf persons. No substantive data has been obtained at the time of this interim report. A preliminary literature search is being conducted, and will appear in a forthcoming report.

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SECTION II

DEVELOPMENT OF INSTRUCTIONAL PROGRAMS AND MATERIALS

The CYBERTYPE® Exercise Series [Appendix B] consists of practice sentences, common letter groups, dexterity exercises, and basic and supplementary word lists which include letters progressively and in sequence, according to the relative frequency of the letter usage in English; *e.g.*, since E is the most frequently used letter, it appears first, then T, then A, *et cetera*.

One experimental teaching program, in addition to introducing the letters in sequence with the most frequently used letters coming first, is based on a story-guide called Cyber-Circus. [Appendix C] It relies on associative principles where the characters and objects in a circus represent the letters and/or fingering positions to be used on the 14-key interface. Another story-guide, O-N-I, which is in the process of being developed, is a second version of the Cyber-Circus approach and is appropriate for teaching more advanced children. Language Arts Exercises [Appendix D] was designed to accompany either of the story-guides for the purpose of correlating the instructional period with the regular classroom language development program.

The research staff and the subjects successfully learned the "Cybercode" through one of the above methods or combinations thereof. New considerations which evolved through the various teaching-learning experiences have given further insight into future training programs. Program modifications, when implemented, could prove more effective than these preliminary and initial efforts. In any event, the instructional programs and materials were effective. They were encouraging and rewarding to student and teacher alike.

2.1 CYBERTYPE® EXERCISE SERIES

These exercises consist of material which the student can establish, and reinforce his motor memory of the dual-code positions for the characters and functions available at the interface. Accuracy, rhythm, and speed are some of the program objectives for these exercises.

2.1.1 PRACTICE SENTENCES

The practice sentences introduce and emphasize specific letters sequentially, according to the probability of their usage, as previously mentioned. Using only letters learned by the student, along with a 'new' letter, at least four sentences are introduced to stress the dual positions of the new combinations. A student using these exercises is encouraged to create his own original sentences, keeping in mind the ground rules that the words and sentences must use only those letters already learned. This approach led to exciting games in which subjects were able to communicate effectively by written symbols. Merely typing his name legibly meant a great deal to the subject.

2.1.2 COMMON LETTER GROUPS

Practice lists of words and sentences which contain common letter groups, or digraphs and trigraphs which occur frequently in English, comprise an aspect of this program. The trigraph, "and", for example, is listed with "band", "hand", "grand", "sandal", and "andante", as well as within sentences such as "Andy has dandy sandals." After practice, typing the letters as groups appeared to become somewhat automatic for the subjects.

2.1.3 DEXTERITY EXERCISES

These exercises, used at the beginning of the lessons, serve to orient students to the dual-input interface. They help the students clarify letter positions and the relationships between letter positions as well as reinforce their memory for symbols. Because they are simple and repetitive, the letter combinations tend to give confidence to the learner, thus encouraging more complex tasks.

2.1.4 CYBERTYPE® WORD LISTS

Two word lists have been compiled to aid instructors and students in forming their own sentences, especially during early phases of training, at which time the student has fewer letters from which to compose words. The CYBERTYPE® Basic Word List contains alphabetically-arranged words which should be familiar to English-speaking children and adults. Each word group contains new letters used with previously introduced letters. The CYBERTYPE® Supplementary Word List follows a format similar to that of the CYBERTYPE® Basic Word List, and differs only in that its words are less commonly used. Words in this list were selected with the thought that instructors and students should add other words whenever they discover particularly appropriate and enjoyable ones.

2.2 CYBER-CIRCUS

The second experimental teaching program currently being developed for use with the dual-input interface is patterned after associative learning techniques. Essentially, a circus story for children, Cyber-Circus gives meaning to letters and their positions in relation to each other. It was generated as a guide which emphasizes that the circus story should be learned first, before the child ever approaches the typing interface. Hence, the mechanical learning process is enhanced and relieved of drudgery by stimulation of the child's imagination.

The story tells about three children named Eva, Tom, and Ann, who represent the letters E, T, and A; Oatmeal cookies, Nuts, and Ice cream are introduced in the story to represent the letters O, N, and I. The circus characters represent other letters of the keyboard. The attention of the student thus secured, the story associations help to impress upon him the positions of the letters on the input machine.

Subsequent to the introduction of the initial group of letters, E, T, A, O, N, and I, the remaining letters are taught in terms of three groups which are represented as circus tents. For example, on the present dual-input, 14-key keyboard, the letter R may be typed using the combination of the index finger of the left hand on the top left-hand row and the right-hand thumb of the right hand is explained to the child as being the entrance "door" of the R tent, and the letter R is then associated with the other key of the dual combination, namely, the left-hand index finger on the top row. The child then learns the functions of the remaining six right-hand keys or finger buttons in combination with what has been taught to represent the R tent button. These six letter functions are represented as objects, characters, and animals belonging to the R tent. These letters are presented both "vertically" and "horizontally"; *i.e.*, in the horizontal array, Skinny, the clown, the large Hen, and the little Dog are introduced. The second row may be introduced horizontally as first the Colt, the Hen on the Ladder, and the Dog on the Monkey's back. Thus, Skinny, the clown, one of the performers in the circus, is introduced as "that clown who rides a Colt." Representing the letters S and C are Skinny and

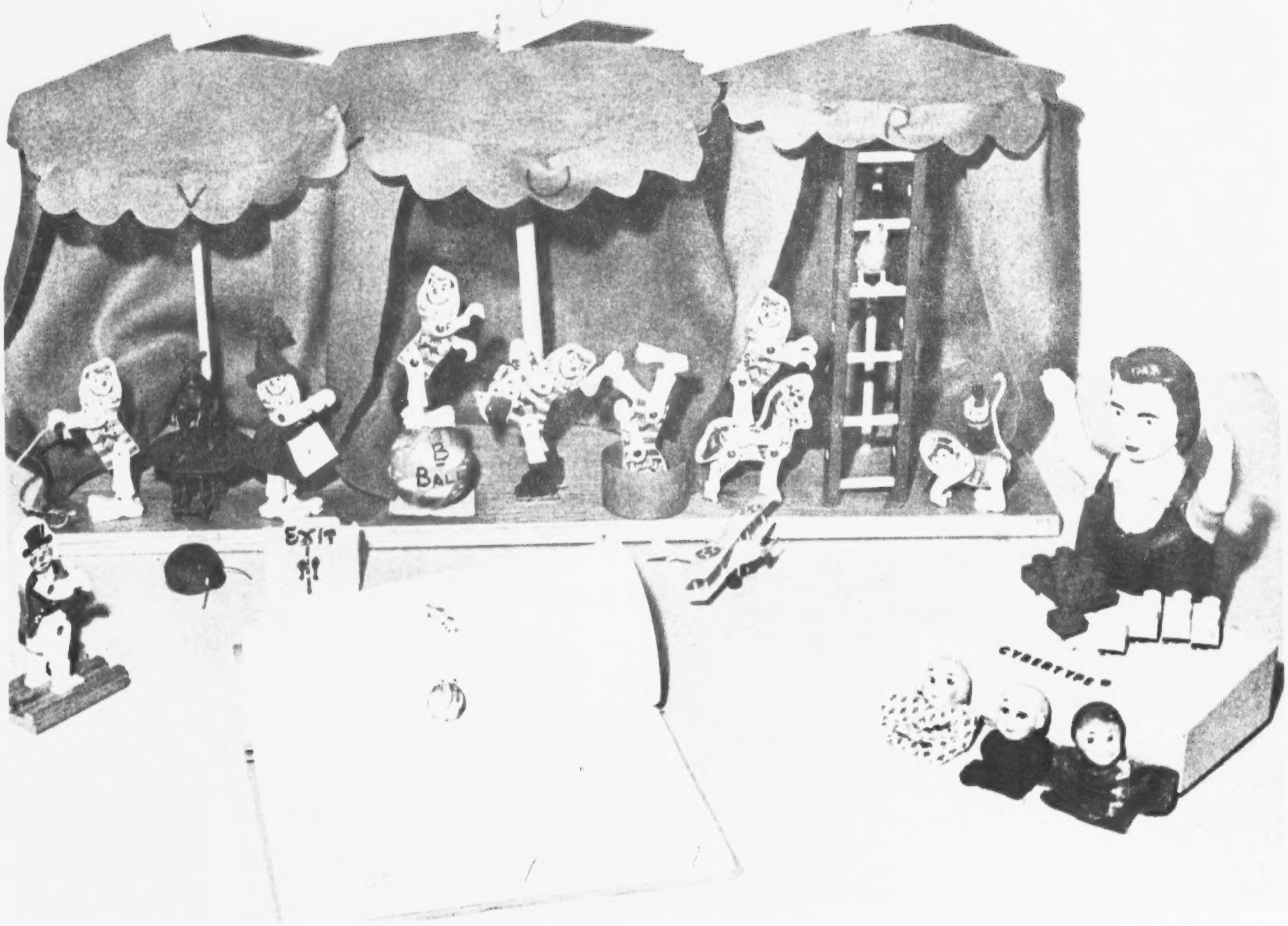
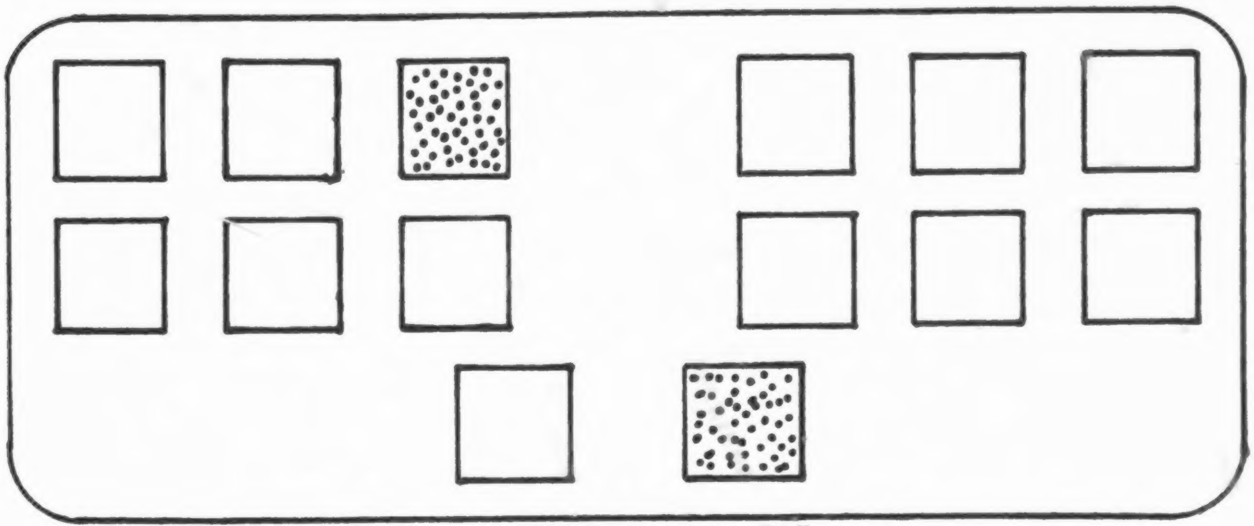
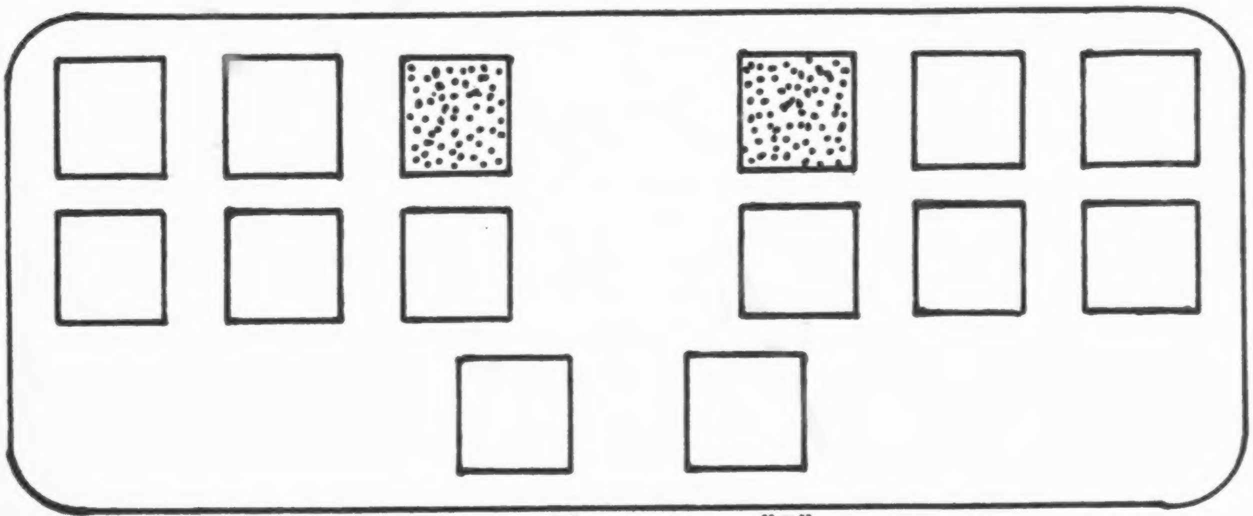

V
U
R
B
BALL
EXIT
CYBERTYPE

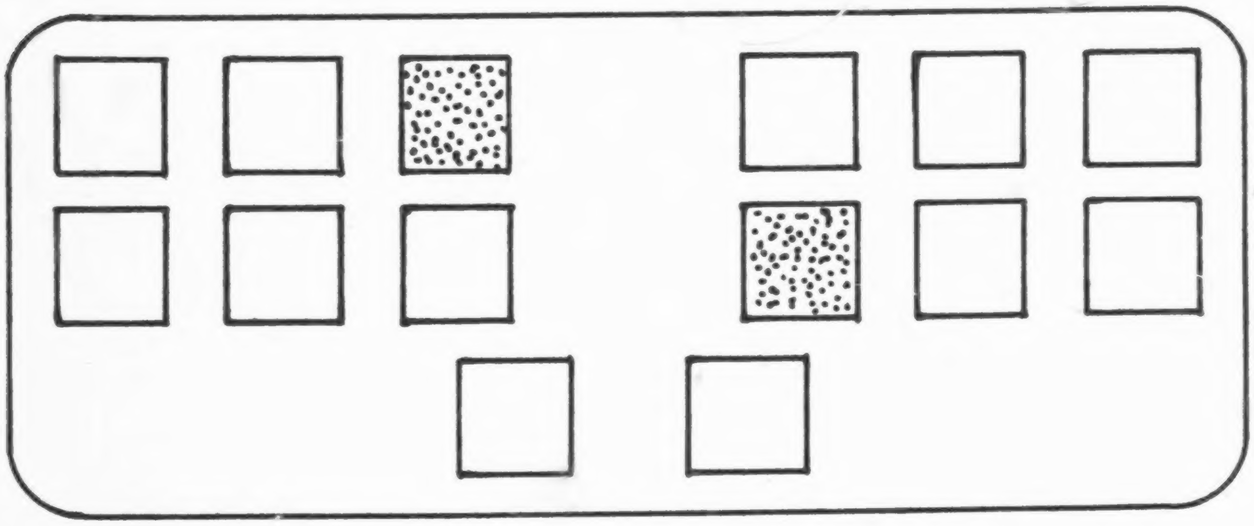
Plate 13. —Cyber-Circus instructional materials. Circus toys and objects used in the Cyber-Circus presentation.



The Letter "R"



The Letter "S"



The Letter "C"

Outline of 14-key CYBERTYPE® keyboard

FIGURE I

the Colt, the one above the other, just as the S and C keys appear on the interface where the S key is on top of the C key. The teacher reminds the children that all of this takes place in the R tent and that "in the R tent" means that the child depresses the key on the top row with the left index finger. Slight descriptive modifications are necessary for children with prostheses.

An inexpensive and colorful model of the circus grounds, along with its acts, attendants, characters, objects and animals can be assembled in the classroom to bring the circus to life. The teacher can use food, balloons, and numerous instructional materials to aid in the reinforcement of the child's learning.

2.3 O-N-I

A second experimental instructional material program, called O-N-I is being developed. It was given a trial with a twelve year old girl with cerebral palsy who is wheelchair-bound. Whereas the Cyber-Circus story is intended for children about six to ten years of age, this version is being designed for older children.

Pragmatically, these associative approaches, thus far, appear most effective for teaching handicapped children the proper positions on the interface. The subjects tested were able to group letters conceptually and their memory appeared to be aided by these associations.

2.4 LANGUAGE ARTS EXERCISES (EXPERIMENTAL VERSION)

The Language Arts Exercises [Appendix D], intended to integrate instruction with classroom language experiences, serves in the development of language concepts. The two parts of the Exercises provide spelling lists and sentences and phrases by which teachers can guide primary and advanced students.

Introduced in the order dictated by the "Cybercode" programming, new letters appear in words containing only previously learned letters. Working with the instructor, the student, by typing, reading, and then studying the words and exercises, can approach word concepts and language structure in a variety of ways. These instructional materials are planned for use with children in special education classes during the coming school year.

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SECTION III

CYBERTYPE® TEACHING AND LEARNING STUDIES

3.1 AMPUTEES

Selection of an amputee was one of the tasks which took place during the initial phase of the project. The principal investigator, with medical consultants and special education specialists, considered two candidates. One candidate, a married female, congenitally deformed by an absense of both arms, and trained to use her feet for tasks normally assigned to arms and hands, was considered unsuitable because of her advanced pregnancy.

The second candidate, a young male war veteran, who had lost both hands and part of both arms and had become monocularly blind as the result of a hand-grenade explosion in Vietnam, was selected as the first subject. He was introduced to the dual CYBERTYPE® code and learned the alphabet coding in two days of concentrated study, while under treatment at Walter Reed Army Medical Center. A template that had outlines of the fourteen keys was used as a mock keyboard. Even though he learned the dual positions of the combinations, his manipulations, at the start, were not controlled with precision.

Subsequently, he became part of the research staff and assisted in the demonstration and testing of typewriter interfaces for use with typing mechanisms. This testing involved finding the appropriate pressure and positions of the keys and/or levers (Plate 5), so they would be firm enough to provide kinesthetic feedback and to activate electrical switches which, in turn, would provide inputs for the typewriter. It was observed that control of his prostheses in various manipulations improved considerably after about three months of training. In six months he became sufficiently proficient to participate in a teaching program at the Belle Willard Elementary School, where he taught the dual programming codes to a congenitally armless child with protheses who learned to operate a modified electric typewriter which uses fourteen keys.

3.2 BLIND CHILDREN

Three blind children were introduced to CYBERTYPE®. One subject was blind due to retrolental fibroplasia. This subject had a mild spastic paraplegia, and a hearing loss in one ear. The teacher, whose academic background was in special education, was also the subject's teacher at The Pilot School for Blind Children, in Washington, D. C. She found the subject's learning of the CYBERTYPE® code to be "much more rapid than with Braille."

It is appropriate to mention that as part of the procedure with this blind subject, contacts were fastened to rubber tips which fit on the ends of her fingers (two contacts each for three fingers of each hand and one contact for each thumb). Using a conductive metal plate as an interface, the child rapidly learned the combinations of "flat" and "tip" finger positions which yielded the letters, numerals, symbols, and other typewriter functions (Plate 6). With the "flat" finger position one does not flex a finger when striking any position on the "Cyberplate". Since there are two transducers located on each of the index, middle, and ring fingers, the subject is taught to flex a finger in order to allow the second transducer, which is worn at the very tip of the finger, to come in contact with the "Cyberplate" (Plate 6).

In those instances where gloves are worn, the transducers are built into the gloves. In one configuration, it is not necessary to use a "Cyberplate" since the application of pressure on the transducers, which can be accomplished by using the thumb for contact, obtains the same results in programming the mechanism.

Variations in the contacts on the child's fingers became necessary to help the young subject clearly differentiate between the two required finger modes. Later, she was transferred to the 14-key interface (Plate 7) without problem; in fact, she had greater success in distinguishing the upper row from the lower on CYBERTYPE® than the "flat" from the "tip" of the finger contacts.

Keyboard variations were tried in order to determine the most appropriate configuration for one of the subjects. The modifications included further raising of the rear keys to aid in spacial recognition of high and low keybank positions. Masking of the keys to aid tactual recognition was also tried. The tilted keyboard seemed to help the child, whereas the masking tape, which gave the keytop a different texture, appeared to disturb this particular subject. The educational program was an early version of the CYBERTYPE® Exercise Series.

Toward the end of one of the instruction periods, the researcher made a serendipitous discovery. This blind child had always had difficulty with spelling, and her sense of phonics, according to teachers who had previously worked with the subject, had been severly undeveloped. At one point, when asked to spell the word "ate", she struggled — and then proceeded to spell "a", "t", "e", with her fingers in CYBERTYPE® code positions, without hesitation, but not on the interface. Thus, the term "Cybertalk" became part of the Cybercom System. The fact that this discovery involved dualism was of paramount significance.

A preliminary literature search revealed that in ancient India, there was a finger communication system called "nirabhasa", where the phalanges represent consonants and the joints, vowels. "Nirabhasa" is not a dualistic system. Kahn (1967) in his text, *The Codebreakers*, states that in India, "Deaf and dumb people still use it, as do traders and moneylenders" (p. 75). Perhaps his choice of the adjective to describe a speech impediment is inappropriate; nevertheless, we learn that the ancients may have used an allusive language for a purpose that was not altogether ethical, but served to assist the handicapped in communicating to their fellowmen.

The second child, also blind due to retrolental fibroplasia, had four hours of teaching during July and August. This child also began by using the "Cyberplate' and finger tip contacts attached to clasps on her fingers, with the letters presented sequentially, according to their frequency. Her difficulties are noted in this description of July 21, 1967, her first lesson: "... she had great difficulty managing the necessary finger manipulation. She found the 'tip' position more manageable than the 'flat' position, but, when she attempted to use one 'tip', the other fingers tended to also make contact." The clasps were too long for her fingers, and as a consequence, in the "flat" position, she tended to hold her finger directly between the "flat" and "tip" contacts.

By contrast to the first, this child became confused when asked to practice the code without the machine present. A parental declamation against such learning appeared to strengthen the child's antipathy toward the idea of typing "in the air." The mother had said to the instructor, "I can't learn things that way! I'd have to have that machine there so I really know I'm doing something." "Cybertalk" in this instance didn't fare too well. A question asked by the investigator regarding this subject was, "Had the child initially learned the dual combinations via finger spelling, or "Cybertalk", without the presence of the machine, would she have remembered the keying positions with greater retentivity?"

During the period of teaching, the child learned the letters E, T, A. O, N, I, R, S, H, D, C, L, and M. She reacted negatively to any pressure applied to speed-up her learning process and, periodically, blocked memory of the "R" position, her teacher observed. This block may have been related to application of pressure, since it had been at the introduction of the "R" position that the teacher was asked by the investigator to "speed it up."

A third child, with serious visual impairments and congenital cataracts, following the rubella syndrome, had a severe hearing loss, combined with a tense home situation. Although his intelligence had never been in question, his attention span had been characteristically short. His prior interest in dynamic toys had indicated to investigators that he might be motivated to take part in the program.

From the beginning of his training program, he reacted positively to the standard electric typewriter and its remote control aspects. It was also observed that this subject was much happier with the code positions for the numbers than those for the letters, since the number code fit predictably with the key arrangement on the standard keyboard, which he could see with his "pinhole" vision capability. Thus he could see with accuracy, the numerals "2" through "0" which he viewed by moving his head and positioning his one eye to about a half-inch from the keytops of the regular typewriter keyboard. As feedback for the subject, the moving key on the keyboard served better than the printed letter on the paper which view was obstructed by the "type ball" on one model and by the ribbon and guide mechanism on another.

The first task here seemed to be to give the child a system by which he could produce something of satisfaction to himself. One such activity was to type an entire line of the same letter or symbol. During the second lesson, he typed well-spaced lines for each number. He learned the "1" position in order to achieve "10" instead of "0" in the "8", "9", "0" series on the keyboard. After typing during part of his lesson, he drew, played dominoes, and worked with wire.

His teacher reported that, because he always looked to her for approval after typing each letter or number, she encouraged him to type a series of letters or numbers before stopping, so as to reinforce his concept of the number and letter systems and to increase his own sense of security. His emotional difficulties appeared to be a major deterrent to this subject's learning, not only on the machine, but also on other mechanisms with which he had been tested. Despite this, this subject learned eighteen dual-keying combinations in about three hours of instruction.

As an outgrowth of this important experiment, "Cyberview", which uses fiber optic mechanisms for immediate feedback, was developed and is presently under study.

3.3 CEREBRAL PALSIED CHILDREN WITH MULTIPLE HANDICAPS

In the pilot program at the Belle Willard Elementary School, in Fairfax County, Virginia, all of the five children who participated as subjects were multiple-impaired.

Three of these children have cerebral palsy; two are wheelchair-bound. One of the latter has the use of only her left hand. The fourth child with a congenital absence of both arms above the elbow, uses two prostheses. The fifth child, also wheelchair-bound, with visual and auditory difficulties, had been affected formatively, allegedly by the drug thalidomide: her hands, extending medially from the elbows, contain four fingers each, and she has a total absence of legs.

The scheduling of investigators' time was arranged so that one investigator was responsible during each child's session for the recording of observations and impressions, and the other was in charge of the teaching program.

Each of the children learned to type with accuracy on the machines provided by CYBERNETICS RESEARCH INSTITUTE. They were installed with appropriate interfaces in a school room assigned to this project. The FILM TRANSCRIPT of the subjects tested appears in Appendix F.

3.4 DEAF TRAINEES

Two deaf adults are in the process of learning to operate the 14-key interfaces. Instruction presented no serious communication problem. They communicated most comfortably between themselves with the light display, "Cyberlamp", display of letters of the manual alphabet (Plate 8).

Sufficient data for evaluation has not been accumulated.

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SECTION IV

PRELIMINARY TEST REPORT

4.1 OBJECTIVES

As a result of the initial success that took place during the first six months of the project, contact was made with the Department of Special Education, Fairfax County Public Schools, Fairfax, Virginia, during the winter months of 1967 (see Appendix H), for the selection of multiple-handicapped children to participate as subjects in a pilot study. The primary goal of this pilot study was to continue in the assessment of CYBERTYPE® and one of the "Cybercodes", a dual-input program, as related to the educational components, with children who were variously impaired. In addition, the investigators sought to obtain information about individual needs which would have a bearing on interface configurations.

4.2 SUBJECTS SELECTED FOR STUDY

Five multiple-impaired children with varying needs were selected for the program. The principle criteria for selecting these subjects were:

(a) that subject was unlikely to successfully operate any standard electric typewriter

(b) that subject knew the English alphabet and was able to read and understand at least a limited number of words

(c) that subject's handicaps were not only different from that of other subjects selected for the study, but also that their disability was considered an extreme case within its own classification.

Of the three boys and two girls selected for the study, one subject's parents moved out of Fairfax County, necessitating the selection of a replacement subject. The new subject was a twelve year-old girl, who, for four years had used a standard electric typewriter. Although she was originally rejected because she did not fit the first criterion, she was later accepted in order that the staff could compare her performance on the 14-key interface with her performance on the standard 49-key typewriter. Table IV contains information on each subject's handicap, sex, age, and intelligence.

TABLE IV

Selected Characteristics of Subjects

Subject	Sex	Age * Yrs. - Mos.	Intelligence	Characteristics
A	M	7 - 3	Average	Cerebral palsy, athetoid; Sclerosis; Wheelchair-bound
B	M	7 - 4	Average	Congenital absence of arms above elbows
C	F	8 - 1	Average or above	Four fingers on each hand; hands extend medially from elbows; Congenital absence of legs; Visual and auditory problems; Wheelchair-bound
D	M	10 - 3	Retarded (educable)	Cerebral palsy, athetoid; Hemiplegia; Hearing impairment; Perceptual difficulties; Speech handicapped
E	F	12 - 10	Average or above	Cerebral palsy; Use of only one hand; Wheelchair-bound; Speech handicapped

* Based on the day instruction started, February 6, 1968

The teaching phase of the project was implemented in February, 1968. The children received individual training twice a week during half-hour sessions. Staff members met with parents and school personnel for periodic conferences about the children's development in the program.

Efforts were made to collect data which might suggest specific modifications in the mechanisms and in the teaching programs, and to determine, from the information gathered, which instruments and procedures might prove useful in future research.

4.3 PLANNED ACTIVITIES

Investigators planned to collect data on subjects with respect to their handedness, visual-motor coordination, visual-motor proficiency in response to symbols, and dexterity - left, right, and bilateral. No standardized testing materials or instruments were located in the literature appropriate to measure these characteristics for the handicapped children included in this study.

Investigators also planned to obtain relevant information from appropriate school personnel and records, physiotherapists, occupational therapists, and consultants. Information from these varied sources was useful for determining (1) the kinds of interfaces required, (2) suitable specific program content and instructional materials, (3) the motivational needs of the subjects.

4.4 IMPLEMENTED ACTIVITIES

General information on each child's background was obtained from school records and personnel. Conferences were held with parents, teachers, Principal, Vice Principal, occupational therapist, and physiotherapist. Modifications of instructional materials and selection of the kind of interface used were ultimately based upon observations of the subjects made by the investigators and consultants.

A task for the children was designed to assess visual-motor coordination when manipulating symbols. The materials for the task consisted of a number of lettered discs and a series of cups arranged in the configuration of one side of the interface. The subject was required to sort the discs into the appropriate cups. Two scores were obtained: time and errors. It was decided, a priori, that the differences between the individuals' handicaps were such as to negate the possibility of intersubject comparisons. It was found that an individual's performance of this task was so variable that intrasubject comparisons, over time, were not feasible.

Since the task required all subjects to sort letters into a configuration paralleling the coding of the interface, investigators had hoped that it might have provided additional insight into the subject's rate of learning. It was concluded that the subject's performance on the mechanism itself proved the most reliable and valid source of information on his learning rate.

Systematic observations of each subject's performance were recorded for each instructional session by a research associate.

Attention was given to such questions as:

Should the interface be split?
How far apart should the keys be?
How large should the keys be?
Should the keys be arranged in slanted rows?
To what degree should rows slant?
To what degree should the interface be raised or tilted?
How much pressure is required to operate the transducers?

Periodically, each child was observed by the investigator and a technician, who made systematic changes in the interfaces. As basis for the changes, the following factors, among others, were taken into consideration: the position of the arms, the angle of the arms, the height of the table, the tilt of the interface, the slanted, or straight arrangement of keys or transducers on the interface, the way the subject rested his hands, and similar basic postural elements involved in the use of the mechanism.

4.5 ANALYSIS OF TYPING SAMPLES

Each child's typing sample from each session, was analyzed to determine the most prevalent types of errors made by the children. Positional errors recorded include vertical and horizontal errors for the right and left hand or prosthesis (Table V). Other errors recorded were double letters, extra letters struck, missing letters, and mis-spacing. The total number of errors and the total number of characters typed per page were also recorded.

TABLE V

Errors per Thousand Characters
Based on Data from Seven Sessions

Subject	Right Hand		Left Hand		Double Letters	Extra Letters	Missing Letters
	V[a]	H[b]	V	H			
A	11	9	15	2	27	11	5
B	4	12	11	0	30	5	2
C	10	7	4	2	11	4	3
D	14	27	9	13	52	13	0
E[c]	3	5	8	2	16	4	2

a. Vertical (V) errors for right and left hands include errors the child made by striking an inappropriate key in the same column as the intended key, an adjacent key in an adjacent column, and the thumb key.

b. Horizontal (H) errors include keys the child struck in an adjacent row, to the right and left of the intended key, and those struck unintentionally on the thumb key.

c. For this subject, "Right Hand", and "Left Hand" refer to the sides of the interface.

Note: For comparison purposes, the rate of errors for all subjects is based on a rate per thousand characters. Total number of characters typed per student ranged from 546 to 1,924 in seven sessions.

Analysis of errors revealed a random structure. Of all errors, there was no pattern discernible either in the vertical or the horizontal keying configurations.

Data from the analyses of selected samples of the subject's typing are summarized in Tables V and VI. Subjects are arranged alphabetically by age, from youngest to oldest. The reader is referred to Table IV and Appendix E for additional information, and Figure II.

TABLE VI

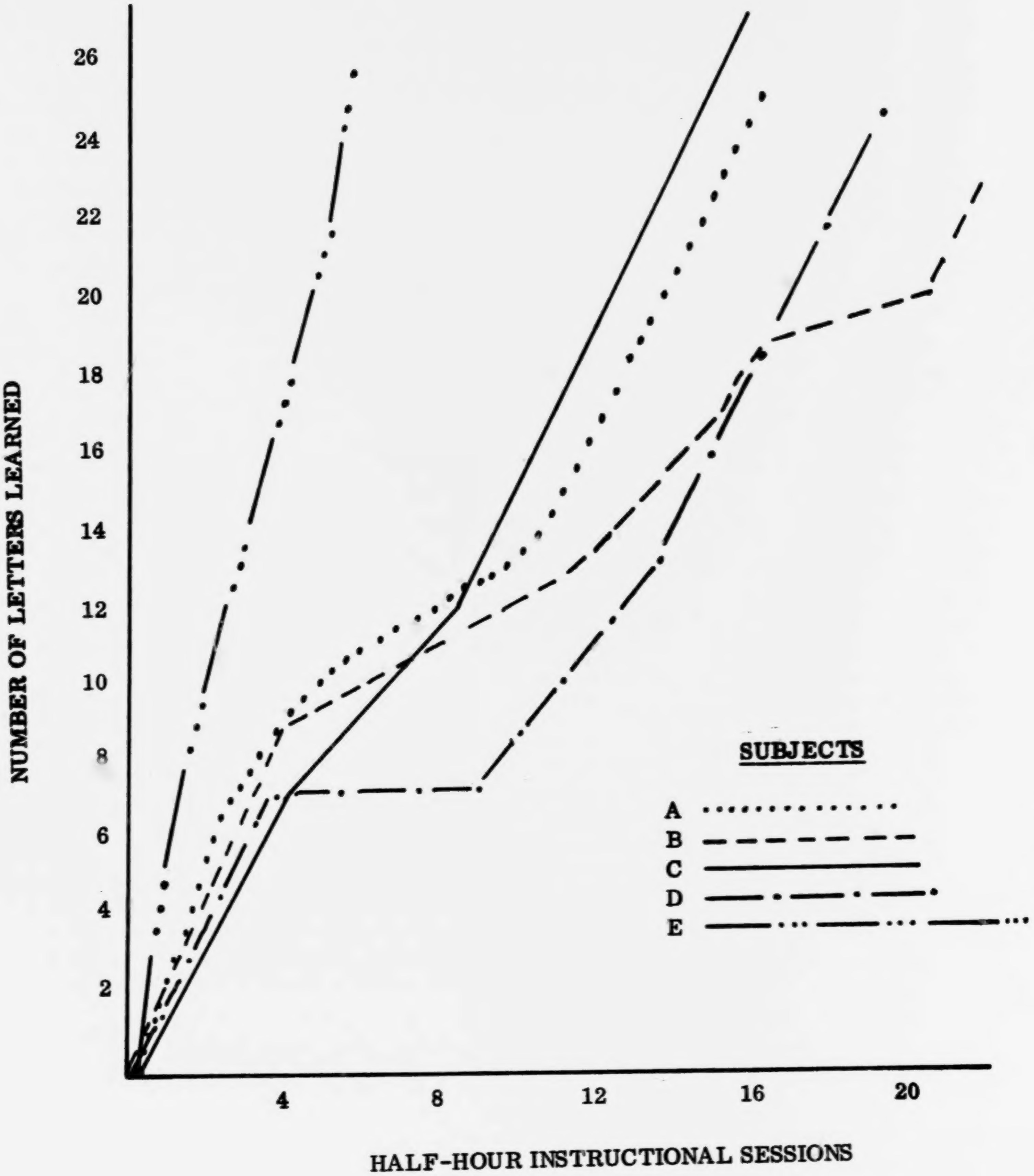
Range and Mean of Number of Characters Typed
Per Session and Total Number Hours of Instruction[a]

Subject	Age Yrs. - Mos.	Range	Mean	Total Hours of Instruction
A	7 - 3	78	56	11.5
B	7 - 4	118	94	14.0
C	8 - 1	160	90	12.0
D	10 - 3	124	89	14.5
E	12 - 10	275	207	11.0

[a] Based on a sample of seven sessions

Note: The "Total Hours of Instruction" are based on scheduled two half-hour instructional periods per week. However, the actual amount of time spent by the subjects at the CYBERTYPE® fluctuated from as little as ten to twenty minutes per session.

Information on each child's performance was systematically collected some of this "information" being in the form of numerical data. The purposes were primarily, (a) to gain insight for future development of materials and programs; and (b) to obtain ideas as to what kinds of observations and data would be more appropriate for future research.



RATE OF LETTERS LEARNED PER HALF-HOUR PERIODS OF INSTRUCTION

FIGURE II

4.6 DISCUSSION

The following must be taken into account when interpreting data presented in the preceeding tables. The top priority in the CYBERNETICS RESEARCH INSTITUTE project at the Belle Willard Elementary School was determining whether the system functioned and could be used by the subjects. As a child's particular physical requirement became known, his interface was modified. There was no difficulty in making these modifications. The CYBERTYPE® system itself, was equipped with "quick connect and disconnect" connectors, thus numerous styles and models of interfaces were tested with subjects without changing the basic system design.

The seven instructional sessions from which data was obtained for Tables V and VI took place from February to May, 1968. Some of the errors, particularly the "double letters", occurred only infrequently toward the end of the project. It would have been desirable, to have calculated cumulative errors for this report; however, this was not feasible, as preliminary analysis had revealed no qualitative patterns of errors. [Table VI] Thus, the data was not condensed.

There is a relationship between numbers of characters typed per session, and mental age [Table V]. This trend appears contradicted by Subject D, but he differs intellectually.

4.7 COMMENTS

Based on the philosophy that statistical analysis from data is "not fruitful unless there are available for study a large number of reports on operations that are roughly similar in nature," (Morse and Kimball, 1963, p. 7) prudence dictates reservation of conclusions until such time that appropriate operational data is available for critical analyses.

4.8 RECOMMENDATIONS

Future search and research programs of mechanisms and methodologies aimed at improving the handicapped child's education may require investigators to better understand the child's physical and mental boundaries and the family's role and influence, "... we now feel a special urgency to help our children to develop those skills which may insure their survival in a rapidly changing world." (Brodey, 1967, p. 80). Thus the handicapped child's environment should be considered more carefully. In addition, questions that deserve consideration are:

(a) What criteria should be set for teaching a handicapped child to communicate via mechanisms and what criteria should be set for determining which children would perform better with mechanisms of the CYBERTYPE® variety as compared with a regular typewriter? In this study, one of the criteria for acceptance into the program was that it had not appeared feasible for the child to type on a regular typewriter. Subject E, who was admitted later in the program to replace a subject who was leaving the area, had typed, with her one usable hand, on a regular typewriter for four years. In four weeks, after only about seven hours of instruction, she was typing at double her former typing rate on the standard electric typewriter; that is, she typed five words per minute on the standard typewriter, and ten words per minute on the CYBERTYPE®. The research staff, as well as the subject, were pleased and impressed. The interface which she used accommodated all fourteen keys in less than four square inches, allowing her to comfortably manipulate with her one hand. This example illustrates one of the difficulties in establishing criteria for accepting subjects in the experimental programs.

(b) How much of a difference is there in a child's performance when using a dual-keying method as compared to a child's performance when using a single-keying method?

(c) What variables (mental abilities, age, etc.) are more important than others (and by how much) when teaching a child to operate these mechanisms?

(d) What is the minimal performance which investigators would accept as a final goal for a particular child? Any standard which might be established would have to take into account a number of factors, perhaps one of the most important being whether the child had any other means of communicating (writing, speech, and/or typing on a standard typewriter) available to him.

(e) What information is necessary and adequate to terminate a child's training on these man-machine systems? What constitutes "evidence" that a child is not likely to attain functional adequacy? Such decisions must be based, ultimately, on research findings, and must take into account what level of performance would be adequate for that child, and how great his needs are for some medium of communication.

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SECTION V

RESULTS

The machines used by the children and investigators were functionally reliable in their operation. No breakdown due to malfunction of components was experienced at anytime. The teaching programs have shown their effectiveness with all subjects tested.

An adult bilateral amputee who had little typing training learned to operate the 14-key interface accurately at variable rates depending on the material typed. This range extended from about 23 to 45 words per minute. He has taught a congenitally armless child who also uses two prostheses.

Blind children were also taught how to use the mechanisms, first by using the "Cyberplate" and "Cybergloves" and later the first 14-key interface with comparative ease. One striking observation was that a blind child who had had difficulty in spelling orally began to spell with her fingers arranged in the dual-fingering typing positions while away from the interface. This happening indicated to investigators the possibility of considering "Cybertalk" - a potential technique for teaching spelling and developing word concepts. One emotionally disturbed, partially blind child did not respond positively to all mechanisms involved.

All five of the multiple-handicapped children at the Belle Willard Project learned to type accurately. A twelve year-old subject with cerebral palsy, and the use of only one hand, doubled her former typing speed, from five words-per-minute on a standard electric typewriter (after four years of instruction), to ten words-per-minute on the one-hand interface (after seven weeks of instruction). Teachers reported a marked increase in using words occurred in the children who participated in this study. One child notably improved his spelling ability during the period of the program.

Teachers who were not part of the CYBERNETICS RESEARCH INSTITUTE program, but who taught the children other subjects at the school, also reported distinct personality differences in some of the subjects after the introduction of instructional materials used in this program. The children's confidence developed with their ability to communicate with the aid of the mechanisms. Although these changes could be attributed to the personal attention received by the children, the fact is that improvements were clearly discerned and clearly positive in the opinion of the investigators and other observers.

Two deaf subjects have learned to operate the CYBERTYPE® mechanism so that they will be prepared to demonstrate "Cyberphone", a portable communication system which uses a 14-key CYBERTYPE® interface.

The utility of the "Cyberphone" with deaf subjects, and with persons with speech impediments, clearly indicates the feasibility of numerous other applications, such as transmission of messages which can be stored on commercial, low-cost "cassette" type magnetic tape containers; and 'played-back' to a typewriter to which a CYBERTYPE® mechanism has been added. Not only can a permanent magnetic record of the transmission be economically obtained, but use of the cassettes for data analysis with an appropriate computer program appears to offer a new aid to educators who wish to collect data in real time from a plurality of geographical sources.

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SECTION VI

CONCLUSIONS AND RECOMMENDATIONS

The primary conclusion reached at the end of the first phase of this program was that the original objectives had been achieved with success. The introduction of new educational developments has brought to the surface the following: (a) a need for behavioral research requirements which must be defined, (b) a need for research and evaluation of designs which must be more analytically considered, (c) a need for theoretical basis to insure generality of research results.

In reference to point (a), the approach during the early phases of this grant was one of observing the behavior of various kinds of subjects who were exposed to a plethora of changing conditions involving equipment, teaching systems, instructors, and learning situations. It was thought that since the project was in an early growth phase, with new ideas dictating changes almost daily, that it would be virtually impossible to perform experimental studies under formal research designs without actually handicapping the growth of new ideas. At that stage, the generation of new hypotheses was thought more important than their validation. But now the time has come for an evaluative look at the many ideas, new equipments, and applications. To this end, at least the following behavioral research requirements must be met:

1. Valid criteria of performance by the subjects for each behavioral measurement situation must be established. As the investigative approach of the project shifts from observation to measurement, the need for a variety of dependent variable measurements which will quantify the performance of the subjects under the influence of the various independent variables is mandatory. Research to identify, operationally define and evaluate the methods of taking measurements, as well as the measurements, per se, must now be undertaken.

2. Research hypotheses must now be stated and experimentally tested so as to permit the evaluation of the methods and techniques used in the attempts to understand and train the subjects.

In reference to point (b), a carefully considered research and evaluation design must be produced. The designs to be applied during the future of the project should adhere to the following basic scheme:

Multivariate research designs utilized in each separate study would appear to be the most feasible approach in efficiently determining significant differences and relationships. The small numbers of subjects, the need for repeated measurements, the lack of homogeneity among the subjects, and the almost certain presence of interaction among the major variables make the judicious selection of the experimental designs an important issue if valid inferences concerning the results are to be made.

In reference to point (c), a theoretical basis to insure generality of research results is needed. The contribution of research efforts to the area of the handicapped will be seen in two ways.

First, there will be the immediate direct effect of equipment and training innovations on the problems of the handicapped. However, research which only has as its goal the putting out of "brush fires" is inefficient and is the basic reason why most applied research efforts are considered wasteful of research resources.

Second, the future research at CYBERNETICS RESEARCH INSTITUTE will become theory-oriented so as to insure the generality of the research results. To accomplish this broader picture of general application certain steps during the future research program must be taken: (1) The hypotheses tested should be deducible from existing theory. In this case the existing theory is basic cybernetics theory with its specific relationships to the problems of learning, perception, and cognitive processes. The validation of each hypothesis deduced from the theory will strengthen the theoretical basis of the research and provide a broader base for future deductions of tenable hypotheses from the theory. (2) Sufficient samples of a variety of types of handicapped individuals must be used as subjects so as to permit broader generality of results. (3) Only broad category rather than specific problem areas should be attacked. This will permit the research to center about the core problems of the handicapped and not apply resources in areas where low pay-off is expected in terms of generalizability.

But since cybernetics is a relatively new science which presently lacks not only nomenclature and agreement in definition, new names as introduced in this report and assigned to the broad area of cybernetics, such as CYBERTYPE® , "Cybergenetics", "Cybersem", "Cyberplate", "Cyberglove", "Cyberlamp", "Cyberview", "Cyberphone", "Cybertac", "Cyberbraille", and HAIBRL may have alarmed, but hopefully have not aroused the critic, for these terms fulfill special needs of identifying new mechanisms and concepts. Furthermore, their introduction only demonstrates the vast area of cybernetics yet to be discovered and understood in special education applications where multidisciplinary approaches can be effectively used in the very same manner in which cyberneticists have previously utilized these concepts to understand both man and his automata in warfare. [Wiener, *Cybernetics--or Control and Communication in the Animal and the Machine* (John Wiley & Sons, Inc.: N.Y., 1948), Introduction, p. 11]

On the other hand, "Cybercom", which the author has introduced in this report and tentatively has defined as "a system constrained to some boundary within which utilization of the principle that intelligence, feedback, regulation, stability, adaptivity, maintainability, and evolutionary programming, are essential for goal optimization," [Kafafian, 1968] is one that deserves criticism, hopefully to improve understanding so that the term has even a richer meaning in a world of man and his automata.

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APPENDIX A

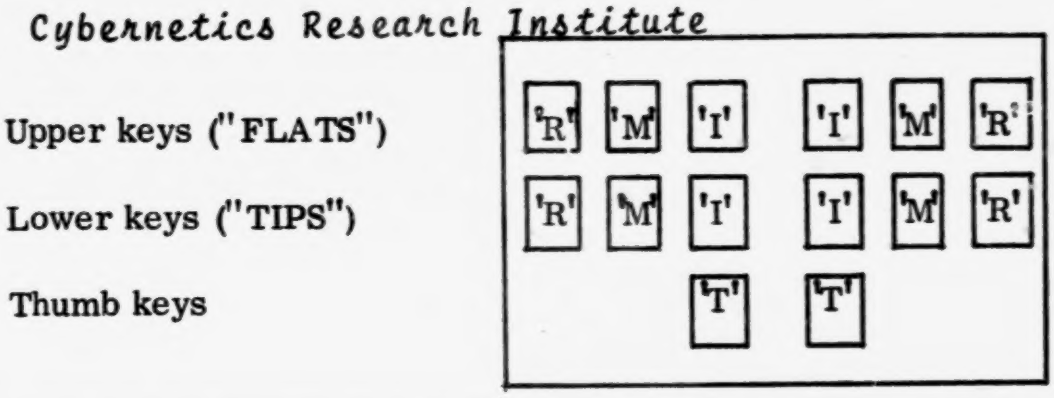
DUAL INPUT PROGRAMMING

DUAL INPUT PROGRAM

The CYBERTYPE® Dual Input Keying Positions Chart and outline of the 14-key CYBERTYPE® Keyboard which follow, show one of the cybercodes used.

In addition Dual-Input Program Charts indicate each letter, symbol or function available on the typewriter used. The shaded key-tops represent the dual-keying combinations.

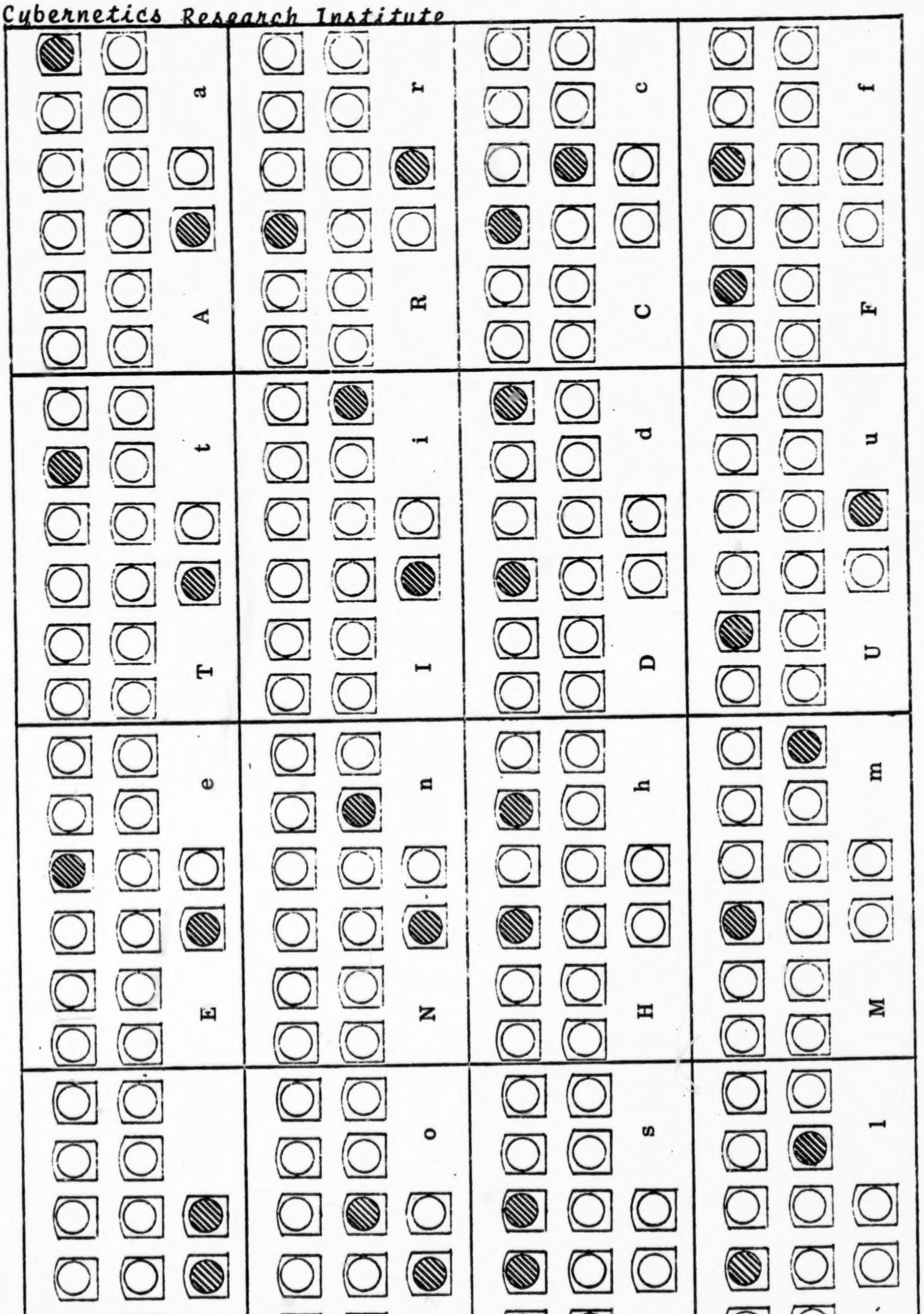
Cybernetics Research Institute


Upper keys ("FLATS")
Lower keys ("TIPS")
Thumb keys
'R' 'M' 'I' 'I' 'M' 'R'
'R' 'M' 'I' 'I' 'M' 'R'
'T' 'T'

'I' = Index finger position
'M' =Middle finger position
'R' = Ring finger position
'T' = Thumb position

& 7	Shift lock	Tab	X x	W w	M m	I i	Ring	"TIPS"	RIGHT HAND
¢ 6	Return	? /	Z z	G g	L l	N n	Middle		
% 5	: ;	, ,	Q q	B b	C c	O o	Index		
$ 4	) 0	" '	. period	Y y	D d	A a	Ring	"FLATS"	
# 3	(9	_ -	K k	P p	H h	T t	Middle		
@ 2	* 8	° !	J j	F f	S s	E e	Index		
∫	Shift unlock	Back space	V v	U u	R r	Space	Thumb		
Ring	Middle	Index	Ring	Middle	Index	Thumb			
"TIPS"			"FLATS"						
LEFT HAND									

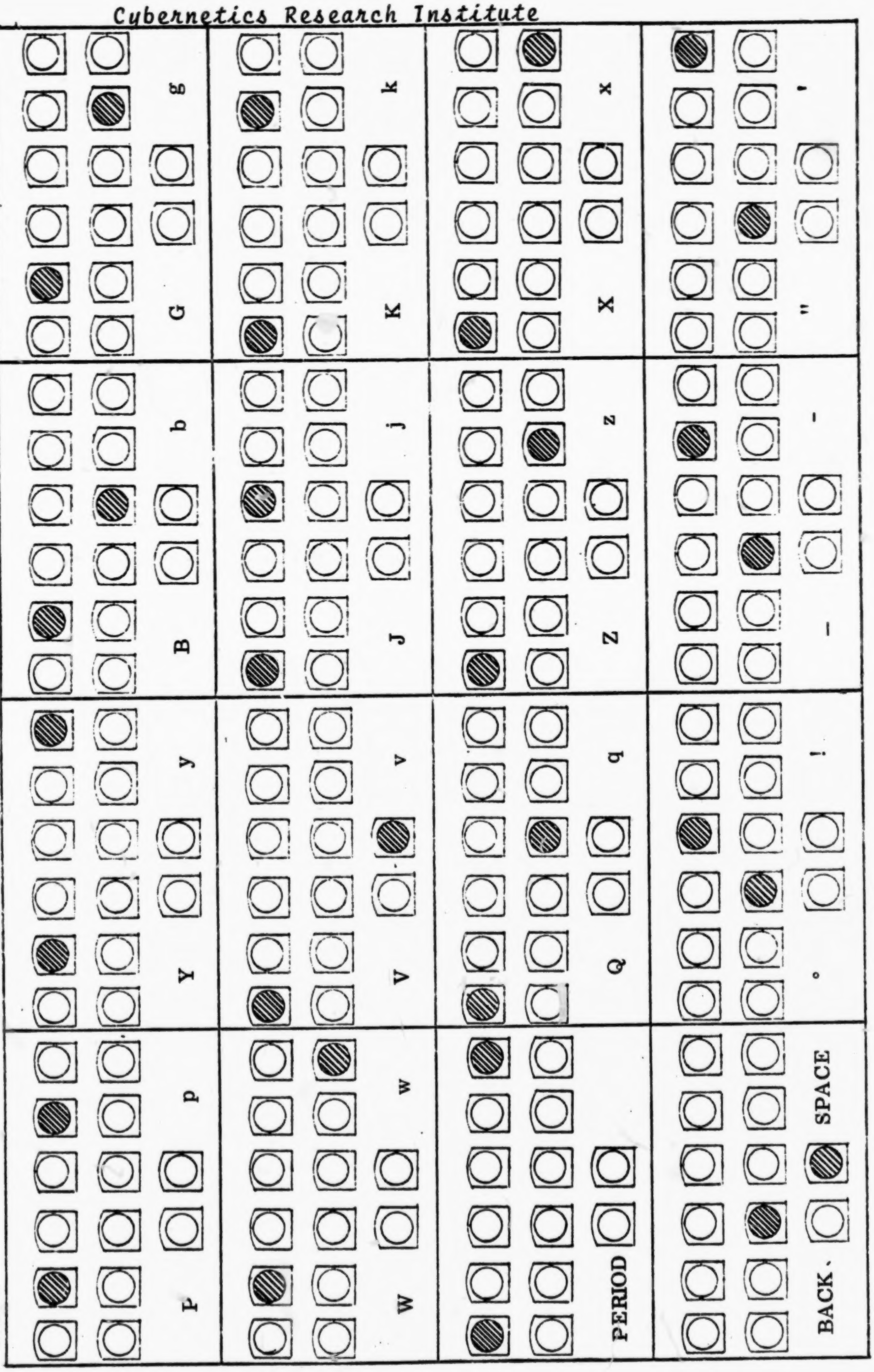
CYBERTYPE® Dual Input Keying Positions Chart


SPACE
E
e
T
t
A
a
O
o
N
n
I
i
R
r
S
s
H
h
D
d
C
c
L
l
M
m
U
u
F
f

Dual Input Program Chart

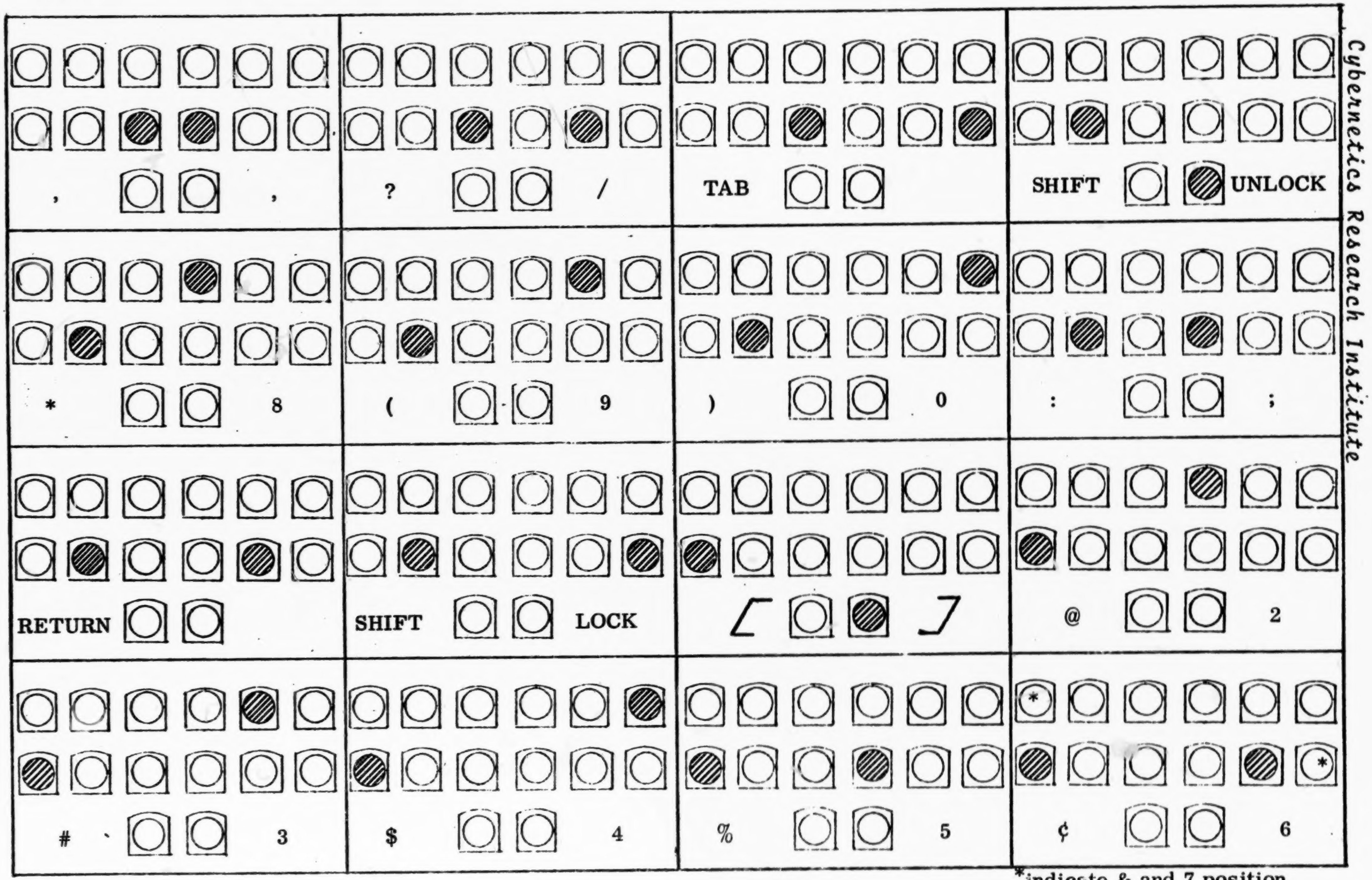
Cybernetics Research Institute

cont'd


P
p
Y
y
B
b
G
g
W
w
V
v
J
j
K
k
PERIOD
Q
q
Z
z
X
x
BACK.
SPACE
°
!
_
-
"
'

Dual Input Program Chart

cont'd


,
,
?
/
TAB
SHIFT
UNLOCK
*
8
(
9
)
0
:
;
RETURN
SHIFT
LOCK
[
]
@
2
#
3
$
4
%
5
¢
6
*
*

*indicate & and 7 position

Dual Input Program Chart

APPENDIX B

CYBERTYPE® EXERCISE SERIES

CYBERTYPE®

PRACTICE SENTENCES

The following sentences are designed to emphasize and reinforce newly introduced letters. For each letter (with the exception of the first six letters) there are at least four sentences, each sentence using the pertinent letter a minimum of three times, and using with it only those letters that have been previously introduced.

Instructors may compose similar sentences for their own purposes by referring to the basic word list.

Students should be encouraged to create original sentences following this pattern. Sentences which "belong" to the student may have considerably more meaning to him, thereby increasing his motivation. If the following (or similar) sentences would tend to inhibit the creativity of certain students, they should not be used. Such decisions must be handled by the teacher, each case requiring individual attention.

PRACTICE SENTENCES

(emphasizing specific letters in order of CYBERTYPE® code letter introduction)

E, T, A, O, N, I

I ate at ten.
I eat one onion.
An ant ate an oat.
At noon I eat in a tent.
A neat teen ate a tan onion in a tin.
I note a nation at attention.

R

A rear tire tore.
A rat ran into a tree.
Aaron ran near a train.
An iron train ran into a rotten tree root.
I enter an eerie terrain.

S

Teens sit on seats.
Toss Rose a stone.
Roast toast is in season.
Sara Stasson stores onions in a stone seat.
A senior senator starts a sensation.

H

She has his hose.
He has thin hair.
He has three shoes.
The hen hit the horse on the shoe. (emphasizing THE)

D

Dad had a red radio.
Hand Dot a dish.
A sad dad had a hot head.
Dad and Ed stand in the sand. (emphasizing AND)
The distant dentist does not season his roast hen.

C

He can catch a cat.
A car can coast.
Cocoa costs ten cents.
Cora can dance the cancan.
A cat can catch a roach.
Richard Rice cheats at cards.

L

Tell Ellen to call.
A late lad eats less.
Let a child lead the line.
Little Nellie lost her doll.
Tell Tillie a tall tale.
Elsa is a real cool doll.

M

Mom made me a mitten.
I smell some meat.
Tell him to come home.
Tom marched almost ten miles.
Mrs. Moon made creamed meat.
A calm clam came late. (emphasizing C, L, M)

U

Stu could use us.
The nurse rushed us out.
Cut a rut under our cute house.
Uncle Curt runs around our church each hour.
Let us discuss musical matters.

F

A fat father fans his face.
Find a foot of felt.
Flat feet often fall.
Find Fran a full loaf.
I fear a fish fell off the roof.

P

Pat planted peas in a pot.
Please pass Paul a pail of paint.
Peter sleeps up on top of a piano.
Pam helped Pat peel potatoes.
Pop slipped and dropped his piece of apple pie.

Y

Sally yells all day.
Fay can only pay a penny.
Dirty dry crayons made Mary cry.
If you do not pay today you may be sorry.
My city already has a candy company.

B

Boy babies bite better.
Bill built a blue boat.
Baby Bess bit her rubber rabbit.
Bob rubbed his bruised bottom.
Beer and beans made Mable burp.
Use your muscles to cut us some lumber.

G

Go get a big bag.
A big ugly pig got angry.
Eggs get bigger in spring.
Gail Higger gets green grape gum.
Angry angels fight grog and eggnog.

W

How now brown cow.
Wild winter winds blow.
We will wash with water.
Willie wants to win a new watch.
Wanda wore a yellow wool wig.

V

I shave every evening.
Brave beavers love to dive.
Give Victor five heavy gloves.
Eve and Harv have every vote.
I have never lived over a valley.

J

Jane just jumped.
Jolly Jimmy enjoys jam and jelly.
John juggles juicy objects.
Major Johnson joined a banjo band.

K

Jack took his bike back.
Kate kissed her black kitten.
I like to bake cookies and cakes.
Dick picked a peck of pickles.

Q

Quit quarreling and be quiet.
The quiet queen requires a quilt.
Form a square quickly and quietly.
A squirrel squeaked and squirted squash.

Z

Bees buzz and zoom lazily.
I need a dozen large size zippers.
The zebra waltzed with the fuzzy bear.
In winter Suzie wheezes and sneezes and freezes.

X

Fix a box for the fox.
Rex will be six next week.
I see six taxis at the next exit.
An anxious axman expects a maximum of sixteen.

PRACTICING COMMON LETTER GROUPS

The following word lists and sentences form a rudimentary example of what may be done to add amusement to the practicing of common letter groups. Students usually find their own favorite words; this search may be suggested by the instructor.

Straight repetition of important letter groups (digraphs, trigraphs, etc.) will probably be found to serve as the most effective form of practice towards the increase of typing speed. However, many students may lose interest and attention when faced with meaningless drills. Here again, the guidance and the judgment of the teacher is essential.

In addition, it is advantageous for the student to learn to use common letter groups in words and sentences, rather than using them purely in repetitive drill.

Thus, sentences such as the following may be used either to provide repetitive practice of common letter groups for the student who will not attend to straight drill of these letter groups, or may be used to supplement repetitive drill.

PRACTICING COMMON LETTER GROUPS

AND

and
band
hand
land
sand
wand
brand
grand
strand
handle
sandal
Andy
dandy
handy
sandy
andante
mandate

Hand Andy and Sandy a handle.
A grand band landed on the sand.
I sand and sand and sand a handle.
Andy has dandy sandals.

ING

king
ring
sing
wing
bring
fling
sting
string
thing
wring
finger
singer
mingle
single
tingle
cringe
fringe
('ing' endings)

Bring the king a ring.
My ring finger tingles.
Sing, sing single singer.
The king is singing and ringing a bell.

TH

than
thank
that
thaw
then
thief
thick
thimble
thin
thing
think
third
thirteen
thirty
this
thistle
Thomas
thorn
though
thought
threat
three
thrill
throat
through
throw
thumb
thunder
Thursday
bath
birth
both
death
earth
fo (u) rth
growth
health
math
path
strength
truth
with
wrath
youth

This is that thin thing.
I think this thimble is thicker than that thimble.
A thorn in the path threatened the growth and the health and the strength of the youth.

THE

the
theatre
thee
theft
their
them
then
theory
therapy
there
these
thesis
they
another
bathe
bother
brother
either
ether
father
heather
mother
other
rather
smother
weather
whether
wither

The cat sat in the hat on the mat.
They like the hat of the other brother.
The ant ate the oat in the hat.

AT

at
bat
cat
eat
fat
hat
mat
oat
pat
rat
sat
vat
brat
flat
spat
that
what
boat
float
ate
date
fate
gate
hate
late
mate
rate
slate
plate
berate

A cat spat at a rat.
A cat sat in a hat on a mat.
I hate late dates.

CYBERTYPE®

DEXTERITY EXERCISES

These exercises are designed for the purpose of developing muscle strength and motor memory. They also serve to clarify letter positions and the positional relationships between letters.

Used at the onset of the lesson, these exercises tend to orient the student to the specific dual input interface that he is using.

Because of their repetitive quality, they tend to be reassuring to the child who is easily threatened by failure. A short period with exercises such as these may serve both to reinforce his letter memory and to permit enough self-assurance to enable him to go on to the more complex writing of sentences.

DEXTERITY EXERCISES

SPACE, E, T, A, O, N, I Group

ETA ETA ETA ONI ONI ONI ETA ONI ETA ONI ETA ONI

EOEOEOE OEOEOEO TNTNTNT NTNTNTN AIAIAIA IAIAIAI

EOE OEO TNT NTN AIA IAI OEO EOE NTN TNT IAI AIA

R, S, H, D, C, L, M Group

RSHDCLM RSHDCLM RSHDCLM RSR SHS HDH RCR CLC LML

SES ESE SES ESE HTH THT HTH THT DAD ADA DAD ADA

COC OCO COC OCO LNL NLN LNL NLN MIM IMI MIM IMI

RERERER SOSOSOS HNHNHNH DIDIDID MAM LTL CEC ROR

MAMA MAMA MAMA MAMA DID DID DID MAMA DID MAMA DID

MALT MALT MALT MALT ANT ANT ANT MALT ANT MALT ANT

SO SO SORE SORE SORE SO SORE SO SORE SO SORE

DICE DICE DICE MACE MACE MACE DICE MACE DICE MACE

MALT OR DICE OR TNT MADE MAMA SO SORE.

U, F, P, Y, B, G, W Group

ETA ONI RSHDCLM UFPYBGW ETA ONI RSHDCLM UFPYBGW

ESF ESF THP THP ADY ADY OCB OCB NLG NLG IMW IMW

UFUFUFU FBFBFBF PGPGPGP YSYSYSY UOU FOF PNP YIY

BENT BENT BENT BELT BELT BELT BELT BENT BELT BENT BELT

WANT WANT WANT FOAM FOAM FOAM WANT FOAM WANT FOAM

GHOST GHOST GHOST PLOUGH PLOUGH PLOUGH GHOST PLOUGH

A GHOST WANTS A BENT PLOUGH BELT.

V, J, K, (.), Q, Z, X Group

ETA ONI RSHDCLM UFPYBGW VJK.QZX UFPYBGW VJK.QZX

RUV VUR ESFJ OCBQ THPK NLGZ ADY. IMWX SP.S

VQVQVQV JQJQJQJ KZKZKZK .X.X.X. VEV QEQ ZTZ XAX

WALK WALK WALK WALTZ WALTZ WALTZ WALK WALTZ WALK

JOE JOE JOE JOE MAX MAX MAX MAX JOE MAX JOE MAX

OVER OVER OVER ROVER ROVER OVER ROVER OVER ROVER

ROVER MAY WALTZ OVER MAX AND JOE.

CYBERTYPE® BASIC WORD LIST

This list is composed of words that are common to the vocabularies of most American children and adults.

The words are arranged in order of CYBERTYPE® code letter introduction. Thus, for each newly introduced letter, there is a list of words containing the new letter used in conjunction with letters previously introduced.

It is hoped that this list may be used to aid CYBERTYPE® instructors and students in the composition of sentences, especially during the early stages of Cybertyping, when the student knows only a few letters.

CYBERTYPE® BASIC WORD LIST

E, T, A

- a
- at
- ate
- eat
- tea

O

- to
- toe
- too
- toot

N

- an
- ant
- neat
- no
- none
- noon
- not
- note
- on
- one
- teen
- ten
- tent

R

- air
- are
- ear
- enter
- entire
- eraser
- iron
- near
- nore
- or
- rain
- ran
- rat
- roar
- root
- rotten
- tear
- tire
- tore
- torn
- train
- tree

S

- also
- as
- easiest
- east
- Easter
- interest
- is
- its
- nearest
- nest
- noise
- nose
- reason
- rest
- rinse
- roast
- rooster
- rose
- sat
- sea
- season
- seat
- see
- seen
- sent
- set
- sir
- siren
- sister
- sit
- snore
- so
- soon
- sore
- stain
- stairs
- star
- start
- station
- stone
- store
- street
- taste
- tease
- test
- toast
- (plurals)

H

- another
- earth
- either
- hair
- has
- hat
- hate
- he
- hear
- heart
- heat
- hen
- her
- here
- hi
- his
- hit
- horn
- horse
- hose
- hot
- neither
- north
- oh
- other
- rather
- share
- she
- sheet
- shine
- shoe
- shoot
- short
- than
- that
- the
- their
- then
- there
- these
- thin
- this
- those
- three
- throat
- tooth

D

ad
add
address
and
dad
dare
date
dead
dear
deer
dentist
did
die
dinner
dirt
dish
distant
do
does
done
door
dot
dress
dried
end
had
hand
hard
head
heard
hid
hide
idea
indoors
inside
instead
need
nod
order
radio
read
red
ride
road
rode
sad
said
sand
seed
send
side
stand
stood
third
tired
trade
tried
("ed" endings)

C

accident
ace
ache
across
act
can
cane
cannot
car
carrot
card
care
case
cash
cat
catch
cent
center
chain
chair
chance
chase
cheat
chin
choice
choose
chose
chosen
coal
coat
cocoa
cone
corn
corner
cost
cross
dance
doctor
each
ice
nice
ocean
once
race
reach
rice
rich
second
teach
teacher

L

all
alone
call
calm
careless
child
children
chocolate
circle
class
clean
clear
close
cloth
clothes
cold
color
cool
cradle
doll
dollar
electric
else
hall
heel
hello
hill
hold
hole
lace
laid
land
last
late
later
lead
learn
leather
led
lesson
let
letter
lie
line
lion
listen
little
load
loose
lose
lost
lot
nails
old
real
roll
sail
salt
school
sell
shall
shell
sold
soldier
steal
still
tail
tall
tell
till
told

M

am
almost
animal
arm
came
chimney
Christmas
climb
come
cream
dime
dream
ham
hammer
him
home
ice cream
lemonade
made
mail
mailman
mama
man
march
matter
me
mean
meat
medicine
meet
melt
men
mend
met
middle
mile
mill
million
mind
mine
mint
mirror
miss
mom
moment
month
moon
more
most
mother
Mr.
Mrs.
name
room
same
seem
slam
small
smell
smile
some
sometime
stomach
storm
team
them
time
tomatoes

U

about
aloud
around
aunt
cause
church
circus
cloud
clue
count
course
cousin
cruel
crust
cure
curtain
cushion
cut
cute
discuss
dust
hour
house
hundred
hunt
hurt
lettuce
loud
lunch
measure
minute
mountain
mouse
mouth
much
muscle
music
muss
must
number
nurse
nut
our
out
outdoors
outside
round
ruin
run
rush
should
shoulder
shut
sound
south
such
suit
summer
sun
sure
thousand
touch
true
turn
turtle
uncle
under
until
us
use
("un"
endings)

F

afraid
after
afternoon
calf
careful
chief
different
face
fair
fall
fan
far
farm
farmer
fast
fat
father
fear
feather
feed
feel
feet
fell
felt
fence
field
fill
find
fine
finish
fire
first
fish
fit
flies
float
floor
food
foot
for
forth
found
four
free
fresh
fried
friend
from
front
fruit
full
fur
furniture
half
herself
himself
if
leaf
left
life
lift
of
off
office
often
roof
self
soft

P

airplane
apple
camp
cap
captain
cup
cupboard
deep
dope
drop
elephant
help
hop
hope
lamp
lap
leap
lip
nap
open
pail
pain
paint
pair
pal
pan
pants
papa
paper
parade
parents
part
pass
past
paste
pat
path
peach
peas
peel
pen
pencil
people
pet
piano
picnic
picture
pie
piece
pin
pipe
place
plain
plant
plate
please
point
pond
policeman
poor
pop(corn)
porch
post
pot
potatoes
pound
present
press
pull
put
shape
sheep
ship
shop
sleep
slip
soap
soup
space
spoon
spot
spread
step
stop
supper
suppose
surprise
top

Y

already
any
candy
city
company
copy
country
crayons
cry
day
dirty
dry
early
easy
empty
eye
family
fly
funny
happy
hurry
lady
lay
many
may
money
my
myself
only
party
pay
penny
play
pony
pretty
puppy
ready
say
silly
sorry
stay
story
they
thirsty
today
toys
try
way
yard
year
yes
yesterday
yet
you

B

automobile
babies
baby
bad
ball
balloon
banana
band
barn
bat
bath
bathe
be
beans
bear
beat
beautiful
because
bed
bee
been
beer
before
behind
bell
bend
beside
best
better
bicycle
bill
bird
birthday
bit
bite
bleed
bless
blood
blue
board
boat
body
bone
born
both
bottom
boy
branch
bread
broom
brother
brush
build
built
bumblebee
bump
burn
burnt
burp
bus
busy
but
butcher
butter
butterfly
button
buy
by
double
habit
lamb
rabbit
remember
ribbon
rob
robin
rub
rubber
table
thumb
tub
umbrella

G

again
against
age
ago
along
angel
angry
anything
bag
bandage
began
begin
begun
belong
big
bought
bright
bring
brought
building
bug
change
cough
danger
dig
dining
dog
drug
edge
egg
eight
engine
enough
fight
finger
flag
forget
forgot
frog
gallon
game
garage
garden
gas
gate
get
ghost
gift
giraffe
girl
glad
glass
go
goat
goes
going
gold
golden
gone
good
goodbye
gorilla
got
grade
grain
grandfather
grandmother
grape
grass
gray
great
green
grocery
ground
guess
guest
gum
hang
high
hung
hungry
large
laugh
leg
light
long
might
morning
neighbor
night
nothing
orange
page
pig
rag
right
ring
rug
sign
something
song
spring
sting
straight
string
strong
sugar
though
thought
through
together
tongue
tough
ugly

W

allow
always
answer
away
awful
between
blow
bow
bowl
brown
clown
cow
crowd
crown
down
draw
drawer
fellow
few
flower
follow
grew
grow
how
low
new
now
own
pillow
row
sandwich
saw
sew
shadow
show
slow
snow
sweat
sweater
sweep
sweet
throw
tomorrow
towel
town
twelve
twenty
two
wagon
wait
wall
want
war
warm
was
wash
waste
watch
water
we
wear
weather
wedding
well
went
were
west
wet
what
wheat
wheel
when
where
whether
which
while
whisper
white
who
whole
whom
whose
why
wide
wig
wild
will
win
wind
window
wing
winter
wish
witch
with
without
woman
women
wonder
wood
wool
word
wore
world
worry
would
wrap
write
wrong
yellow

V

above
alive
believe
brave
cover
dive
drive
drove
eleven
even
evening
ever
every
everything
five
gave
give
glove
have
heavy
leave
leaves
live
love
move
never
over
overalls
prove
river
save
serve
seven
several
shave
shiver
silver
stove
twelve
valley
vanilla
velvet
very
vine
violin
visit
voice
wave
weave

J

jail
jam
jar
jelly
job
join
joy
juice
jump
just
pajamas

K

ask
awake
awoke
back
bank
bark
basket
beak
bike
black
blackboard
book
break
breakfast
brick
broke
broken
cake
check
cheek
chicken
clock
cook
cookie
crackers
creek
dark
drink
duck
fake
fork
handkerchief
joke
keep
kept
key
kick
kill
kind
king
kiss
kitchen
kitten
knee
knew
knife
knock
know
lake
like
lock
look
make
mark
market
milk
monkey
napkin
neck
nickle
park
peck
pick
pickle
pocket
rock
sack
shake
shook
sick
silk
skates
skin
skirt
sky
smoke
snake
socks
speak
spoke
steak
stick
stocking
strike
suck
take
talk
thank
Thanksgiving
thick
ticket
took
truck
wake
walk
week
work

Q

quack
quarrel
quarter
queen
question
quick
quiet
quit
quite
square
squash
squeak
squirrel
squirt

Z

breeze
buzz
crazy
dozen
freeze
frozen
fuzzy
jazz
lazy
prize
puzzle
quiz
raze
razor
size
sneeze
waltz
zebra
zero
zipper
zoo
zoom

X

axe
box
except
excited
expect
exit
fix
fox
mix
next
six
taxi

CYBERTYPE® SUPPLEMENTARY WORD LIST

This list follows the pattern of the CYBERTYPE® Basic Word List, *i.e.*, words are listed beneath each newly introduced letter, using with that letter only letters which have previously been introduced.

Words on this list tend to be less common than those on the Basic Word List.

As every word in any dictionary could fit into some category in this list, the list makes no attempt at being complete. The CYBERTYPE® Supplementary Word List should be augmented as the teachers and students discover words that they especially enjoy.

CYBERTYPE® SUPPLEMENTARY WORD LIST

E, T, A

tee

O

oat
tot
tote

N

Ann(e)
ante-
Nan(ette)
net
onto
tan
ton
tone

I

Annie
anti-
attention
nation
nit
tin
tine
Toni

R

art
eerie
enter
entertain
entire
entrain
errand
intra-
irate
inter
orate
oration
oratorio
ornate
rant
rare
rate
ration
rear
rent
retain
retina
retire
rot
rotate
rotation
rote
tar
tatter
tenor
terrain
terrace
terrier
terror
titter
traitor
tremor
trio

S

arise
arose
ass
astir
ease
easel
inset
insert
insertion
onset
raise
restate
restore
risen
saint
Santa
Sara
satiate
satiation
satirist
sear
seer
senior
senator
sanitation
senor
senorita
sensation
sense
sere
serene
series
setter
sinister
satin
sire

sister
snare
sneer
snort
soar
sonata
sort
staid
stain
stare
state
steer
stereo
stern
stint
stir
strain
strainer
striation
tennis
tense
tension
terse
torso
transit
tresses

H

crash
ether
hare
harness
haste
hearth
heath
heir
hi
hint
ho, ho, ho
host
hostess
inherit
rash
rasher
shade
sheen
shone
shore
shred
thee
throne
thrash
thresh
sheer
shorn
shear
shed
theatre
thee
thesis
thirteen
thorn
threat
threaten
inherit

D

ade
aid
addition
ardor
dairies
Dan
darn
dash
dean
dearth
deed
den
dent
diaries
disdain
distress
dissonant
doe
Don
drain
dred
Hades
hardness
heed
indent
odd
rant
redone
reed
rid
rod
rodeo
shard
steed
strand
tad
Ted
tend
threat
tred
thread
trend
trod
dais
arid
raid
denied
indeed
diet
edit
tide
tied
tender
detonate

C

acre
ancient
ascot
cad
cadet
Canada
cancan
cancer
candid
candidate
candied
candor
cane
canine
canned
cannon
canoe
canon
cant
cantata
canteen
canter
Cantonese
cantor
carat
carcass
card
cardiac
careen
career
caress
caret
carnation
carrier
carrion
cart
carton
cartoon
cartoonist
cascade
cash
cast
castor
cataract
catarrh
catatonic
cater
cater-corner
cathedral
Catholic
catsup
censor
center
certain
cess
cessation
chant
chaos
chaotic
character
characteristic
chart
charter
chassis
chaste
chasten
chatter
cheer
cheeriness
cheetah
cherish
chess
chest
China
Chinese
chit chat
choir
chord
christen
Christian
cider
cinder
citation
cite
citron
coach
coarse
coast
cod
code
coercion
cohere
coherence
coherent
cohesion
cohort
coin
coincidence
concentrate
concert
condense
condescend
condition
consort
contest
core
cornea
corset
cotton
crane
cranial
crash
crate
crease
create
creation
credence
credential
credit
creed
crisis
critic
criticize
crochet
cronies
decrease
dictate
direct
edict
etc.
historic
icon
inane
incandescence
incantation
incarcerate
incarnate
incense
incessant
incest
inch
incident
incinerator
incite
indecent
rhinoceros
roach
sarcastic
scathe
scion
sector
sonic
stitch
tonic
trace

L

Alan
ale
Alice
alien
Allen
allocate
allot
cancel
cartel
castle
chill
clad
claret
clash
classic
cleat
coil
critical
crocodile
dale
dallies
dandelion
deal
dealer
delicate
detail
dilate
dill
distil
eclat
elastic
elated
Ellen
entail
install
instill
lad
laden
lash
leader
lean
lease
least
less
lice
license
lilt
load
location
loose
lose
redeal
reel
relate
relation
role
sailor
sale
sallies
sartorial
satellite
scale
seal
shill
shrill
silence
sill
slant
slate
snail
sole
stalactite
stale
stall
stallion
steel
tale
tonsil

M

admire
admonish
aim
alms
amen
amend
calm
camel
chasm
claim
clam
coma
condemn
cram
cremate
cremation
crime
criminal
crimson
dam
dame
damn
damnation
demonstrate
dominant
dominate
doom
emit
estimate
ham
hen
immense
imminent
item
lame
lime
malaise
male
mandolin
mane
maniac
marshal
mason
master
masticate
mate
meal
mendicant
mention
merchant
mere
merit
mesh
meteor
million
millstone
mislead
misled
mistress
misunderstand
mitten
moan
moat
moccasin
modal
mode
model
moderate
modern
modest
Mohammed
molar
molasses
mold
molder
mole
molt
molten
mom
monarch
monastery
monitor
monocle
monolith
monologue
monopoly
monster
mooch
mood
moonstone
moose
Moses
remonstrate
remote
salamander
similar
simmer
slim
slime
smite
stream
tame

U

accountant
acute
allude
aluminum
caustic
caution
circuit
conundrum
counter
couth
curse
daughter
doughnut
dual
dune
eunuch
hue
humanitarian
humdrum
illustrious
innundate
humor
innuendo
intuition
lattitude
ludicrous
medium
muslin
nuisance
occurrence
oust
restaurant
resume
rheumatism
rotund
rounded
ruthless
salute
sodium
stout

U/F

stratum
tarantula
tenuous
tumultous
tundra
ulcer
ultimatum
umbrella
understood
undone
undue
undular
unit
unite
unlearn
unloosen
until

F

affectionate
affluence
artifact
artificial
caffeine
chaff
chauffeur
confusion
daffodil
defiant
deft
defunct
duffle
effort
facetious
faille
fallen
falter
famous

F (con'd)

fault
fearful
feature
feudal
floss
flounder
founder
fulfill
further
future
harmful
heifer
huff
infamous
infiltrate
infinite
leaflet
loafer
manufacture
muffin
muffler
officer
officiate
raffle
raft
rafters
refinish
refresh
rifle
rift
ruffle
scaffold
scuffle
shuffle
soulful
stiffener
stuff
taffeta
tiff
tuft

P

appear
appearance
applesauce
application
appoint
appointment
appositive
appreciate
apprehend
approach
calliope
canteloupe
capital
capitol
capitulate
carpet
carport
contemptuous
cope
copperplate
crabapple
creep
crepe
crop
dapper
dapple
depress
dipper
displace
dispossess
duplicate
emphasis
emphatic
epithet
erupt
flap
happiness
impact
implicate
import

P (cont'd)

important
impound
input
lapel
leprechaun
Lilliput
manuscript
maple
Neptune
opener
opulent
opus
output
pamper
paperclip
parachute
parapet
paraphernalia
passport
patent
pent-up
peppermint
perception
permanent
person
perspriration
phase
plump
poplin
poppies
port
proper
prosperous
pulp
purple
rapport
rapture
sculpture
slipper
spontaneous

P/Y

spout
sulphur
suppine
suspect
taper
temper
Tippecanoe
topple

Y

accuracy
affrontedly
airy
ally
appendectomy
Cheyenne
corduroy
cybernetics
CYBERTYPE®
cyclist
daily
doily
dynamic
eddy
employment
fairy
fantasy
ferry
finery
folly
hairy
hurry
hyacinth
hydrophobia
itchy
liability
loyalist
martyr

Y (cont'd)

maybe
mayonnaise
myopic
mystic
mythical
neutrality
nullify
nylon
oyster
plurality
pterodactyl
pyramid
rayon
rhyme
rhythmic
roundelay
rye
satyr
schoolyard
shifty
silly
supremacy
symmetry
symphony
synonym
telepathy
thyroid
timely
tiny
trolley
tummy
tyranny
yacht
yahoo
yearly
yeast
yell
yen
yonder
youth

B

adduction
ability
about
abrupt
absolution
abuse
affable
ambrosia
ambush
amoeba
amphibian
babble
bachelor
ballistic
ballet
barefoot
beaurocrat
binder
blind
blubber
blunderbuss
blusterous
breathe
bubble
bundle
bouyant
clobber
cobbler
cumbersome
cummerbund
dabble
debonair
diabolic
dubious
ebulient
elaborate
embrodiery
establish
establishment
eyeball

B (cont'd)

fable
fabrication
fabulous
fib
fibrous
habitat
harbor
herbiferous
hobble
hubcap
husband
imbibe
imperceptible
inborn
incumbent
insurmountable
labor
laboratory
labyrinth
landlubber
mobile
nubby
parable
plebeian
publication
rabble
reimburse
remember
rhombus
ruby
sabbatical
saber
stubborn
subculture
sublime
subliminal
submarine
substitute
subsystem
tambourine

G

aggravate
aggregate
agitate
agog
agriculture
allegation
ambiguous
among
analogy
apology
argue
arrogant
badger
baggage
bagpipes
barrage
beguile
beige
biology
carriage
cogent
colleague
congruent
damaging
dagger
dungeon
eaglet
egad
eggplant
energy
eulogy
figment
filigree
gabardine
gadget
gigantic
giggling
gladiola
glib
gossamer

G (cont'd)

gregarious
groggy
grouchy
gutteral
hanging
harangue
hieroglyphics
igloo
ignite
ignoring
lagging
language
languish
logging
lounge
lunge
magenta
magnetic
malign
neurology
nudge
outgoing
outrageous
pageant
polygamy
psychology
regard
regenerate
regional
register
regret
sagebrush
sargeant
scourge
surgery
tangy
tutelage
undergo
ungeared
unglued

W

allowance
bellows
bestow
bewilder
blowfish
bobwhite
brawny
cowardly
dawdle
dew
dowager
dowdy
downhill
dowry
farewell
flaw
glower
glowworm
gnaw
growl
hallowed
handiwork
howl
impower
inchworm
lawful
lewd
lowland
newfangled
nowhere
outwit
overwhelm
pawn
pewter
powwow
reward
rowdy
showman
stowaway
sunflower

W (cont'd)

swift
switch
sword
sworn
thaw
unwind
unwarranted
waft
wandered
watercolor
waterwheel
wayfarer
wherefore
whopper
withdraw
wonderful
wonderworker

V

affidavit
anchovy
avalanche
avocado
avocation
beverage
bravado
bravery
cavern
circumvent
convent
convert
deliver
delve
devaluate
divergent
diversive
dividend

V (cont'd)

Evangeline
eventful
eventual
evolve
flavoring
gravy
grievance
grooves
harvest
heaven
irrelevant
leavetaking
level
loaves
mauve
navigate
neverland
overt
overdo
pave
poverty
prevail
rave
resolve
revelry
revive
rotogravure
shove
survive
travail
universal
university
unwavering
vague
varied
vault
velvet
verify
vesper

V/J

vestibule
vineyard
vivacious
vivid
vulnerable
waver
wherever
woven

J

adjacent
adjective
adjudge
banjo
bejewel
cajole
conjecture
conjugation
conjunction
conjure
dejected
eject
enjoyable
injunction
injury
injustice
jargon
javelin
jocular
jolly
jubilation
jubilee
jujitsu
justice
justify
majesty
majority

J/K

ouija
pajama
perjury
projectile
reject
rejoice
rejuvenate
sojourn

K

askance
awkward
backward
balk
bask
biweekly
bleak
bleat
booklore
cask
crackle
damask
embark
eureka
flank
gawky
grackle
hijack
hollyhock
junket
kayak
keystone
khaki
kilocycle
kink
knavery
knead

K (cont'd)

lawmaker
marketable
parka
pumpernickel
rakish
reckless
risky
seersucker
silken
skillful
skyward
thunderstruck
tucker
ukulele
unkempt
wakeful
waterworks
yoke

Q

acquiescence
acquit
aquamarine
arabesque
barbeque
bequeath
biquarterly
bouquet
brusque
clique
coquette
curlique
disquiet
equality
equivocate
harlequin
inequity
Jacquard

Q/Z

kumquat
lacquer
liquid
masquerade
opaque
piqued
prerequisite
quality
quandary
quantity
quest
quotation
quote
quotient
requirement
roquefort
tranquil
unique

Z

ablaze
baptize
brazen
buzzard
cognizant
czar
economize
emphasize
fez
grizzly
harmonize
hazzard
immobilize
jazz
Jezebel
kazoo
Lazarus
laziness

Z/X

mazurka
Mesozoic
mezzanine
mezzo soprano
monopolize
naturalize
Paleozoic
pulverize
quizzical
razor
sleazy
soliloquize
sympathize
tizzy
utilize
whizzing
wizzard
zealot
zephyr
Zeus
zigzag
zillion
zinc
zither

X

axiom
axis
Biloxi
Delacroix
dexterity
exacting
exaggerate
example
excavate
excelsior
exception
excitement

X (cont'd)

exclude
explain
export
extravagant
fixation
foxglove
hexagon
hoax
index
laxness
maximum
nix
noxious
oxcart
perplex
pox
reflex
saxophone
tax
toxic
vex
waxing
xylophone

APPENDIX C

CYBER-CIRCUS

CYBER-CIRCUS

Cyber-Circus, one of the teaching aids (see Plate 13) for use with CYBERTYPE® , is designed to hold the child's interest while, at the very same time, improving his typing ability and motor memory.

Eva, Tom, and Ann jumped up and down with joy when Mother announced that she was going to take them to the circus. When Eva, Tom, and Ann were ready, Mother told them about another treat. They would be permitted to buy one of their favorite foods to take along to the circus.

Eva bought Oatmeal cookies.
Tom bought Nuts, because Tom just loves Nuts.
Ann's choice was an Ice cream bar.

Note: when you identify the first letter of each name in the story, the letter associations would appear as follows:

Eva Tom Ann --- E T A
Oatmeal Nuts Ice cream --- O N I

Eva, Tom, and Ann dashed to the store, made their purchases, and returned home, breathless, to meet their mother, who was ready to leave. Off to the circus they hurried. As Eva, Tom, and Ann stepped off the bus, Eva shouted, "There's the circus, near that big elm tree!"

Then Eva, Tom, and Ann listened as one of the circus barkers yelled to tell everyone where the three tents in this circus were located.

"These tents are the "R", "U", and "V" tents" said Mother, as she repeated the barker's announcement.

Eva, Tom, Ann, and Mother walked from the right to the left side of the arena where "R", "U" and "V" tents were located. "The first tent, the "R" tent is here," cried Eva, "I can feel a letter "R" on the first tent. This is the "R" tent."

(Note to teacher of blind children: Have a letter "R" and a Braille "R" on the first tent.)

Going further to his left, Tom found the "U" tent. It was next to the "R" tent. "This is the "U" tent," shouted Tom. While Tom was busy inspecting the "U" tent, Ann located the "V" tent. "We sure do have three tents," said Eva, "because I found the "R" tent, Tom found the "U" tent, and Ann found the "V" tent."

In front of the "R" tent was a man wearing bright checkered knickers and a silk top hat, calling all the people through his megaphone: "Come one, come all, to the greatest show on earth. The show in the "R" tent is about to begin."

"That man is a barker," said Mother. "Every circus has a barker who makes all the announcements. He is a man who tells all about the show at the circus."

Eva, Tom, and Ann ran to find good seats. The barker came into the tent and stood on a platform bellowing through his megaphone, "Ladies and gentlemen, we have three rings in the center of the "R" tent, and there will be a different show in each ring." He tipped his silk top hat and he left the arena.

In the first ring was Skinny the clown riding on a Colt's back. Skinny held on tightly so that he would not fall off. It was a good and exciting act. While Skinny was riding around and around the ring, Eva called, "Hold on Skinny, don't fall off that Colt's back."

S
C

Tom clapped and clapped his hands until he felt them sting. Suddenly he stopped as a large Hen with wings flapping and fluttering climbed a Ladder in the second ring. That Hen is very brave," said Mother. "Gosh," cried Tom, "I hope the Hen does not lose her balance." "Just imagine," said Tom, "a Hen on top of a Ladder."

H
L

In the third ring, Ann heard the scampering of feet and the pitter-patter of more feet dashing around the ring. "What is happening, Mother?" cried Ann. "Everyone in the circus is jumping up and down and clapping their hands." "A little Dog is chasing a big Monkey," said Mother, "and now the Dog is on the Monkey's back."

D
M

Mother was delighted that Eva, Tom, and Ann were having such a delightful time. "If the "U" tent and the "V" tent have shows as exciting as the "R" tent, just imagine how much more fun we all shall have," said Mother.

Note: The story of the "R" tent would appear somewhat as follows:

"R" Tent Skinny Hen Dog --- S H D
Colt Ladder Monkey --- C L M

Going out of the "R" tent and to their left, Eva, Tom, and Ann ran to the "U" tent where another circus show was to take place. As they were hustling to get good seats similar to seats they occupied in the "R" tent, Eva, Tom, and Ann heard the well-dressed barker calling, "Come one, come all, to the greatest show on earth, the "U" Tent show is now about to start.

The barker hustled on a platform of the "U" tent and yelled, "Ladies and gentlemen you are in the "U" Tent and this tent is the clown tent." "This will be the funniest show of all," said Eva. Mother told the children about the clowns with their baggy clothes and big, big, enormous shoes.

Tom clapped and clapped his hands when Flippo clown hopped on a large Ball and rolled it around and around the ring. "He stayed on that ball," said Eva, "he has never fallen off." "Mother, Mother," shouted Eva, "Flippo is balancing himself on top of that big ball."

F
B

Tom roared with laughter as Poppo, a clown on skates, came skating around and around the ring. "I can skate that fast too," said Tom. "Is Poppo holding something, Mother?" asked Tom. "Yes, Tom," said Maother, "Poppo is holding a little Goat by his feet as he is skating around the ring." The goat was wiggling and waggling. "Oh, the Goat broke loose and got away from Poppo," cried Mother. Poppo skated fast and then faster until he again caught the little Goat. Poppo took the Goat by his feet and skated around and around the ring. Tom clapped and clapped his hands, hoping that the Goat might break away again, from Poppo but Poppo held on tightly. "That Goat enjoyed the trick as much as Poppo, " laughed Mother, "and Poppo liked being on top of the Goat."

P
G

The third ring was the mystery ring. "Isn't something happening?" cried Ann. "Everything is so quiet," said the children. Suddenly, they heard a loud sound; it was the roar of a miniature airplane flying above their heads in the "U" tent. The airplane flew high, it flew fast over the "U" tent and then it returned. What excitement! What a splash! A big clown dressed in yellow with a big Y letter painted on his yellow baggy coat parachuted from the airplane into a Water tank. Everyone was jumping up and down in his seat. Ann stood up on her chair and clapped and clapped her hands and cried, "Mother, I think the "Y" clown parachuting into the Water is one of the best acts, don't you?" What fun it was, watching the "Y" clown swim out of the Water tank. (Here as in other instances, the teacher can ask questions; for example: "Why they named him the "Y" clown?")

Y
W

Note: The story of the "U" tent would appear as follows:

"U" Tent	Flippo	Poppo	Y clown	--- F P Y
	Ball	Goat	Water tank	--- B G W

Since the acts in the "U" tent were completed, Eva, Tom, and Ann ran out of the "U" tent and into the "V" tent. The children were seated before the show started. "My goodness, a cowboy with a long rope or lasso, is running into the first ring," cried Mother. Mother was so excited for she always liked cowboy acts. Everyone at the show clapped and screamed for the cowboy. Jay, the big cowboy, was twirling and twirling his lasso. Jay was no amateur for he had indeed repeatedly practiced and practiced his tricks. He could make all of the letters of the alphabet with his lasso. Then he quickly made the letter "Q", and Mother whispered quietly, "Children, I think he is really wonderful."

Tom jumped up and down as he heard a large bee chasing a Kangaroo into the second ring. The Kangaroo was so frightened that he leaped on top of a table located in the center of the arena. The bee spied a caramel popcorn on the floor and quickly forgot all about the Kangaroo. The Kangaroo could not figure out why the bee did not follow him up on the table until he looked down on the floor and saw the bee buzzing away eating the popcorn. He could hear the bee going zzzzZZZZ. With the frightened Kangaroo up on the table and the busy bee down on the floor making a zzzZZZzzzZZZ sound, it was a funny situation. "Wasn't that funny, Mother? A Kangaroo on top of a table and a bee going ZZZzzz on the floor," said Tom.

K
Z

Even though the show was almost over, there was so much excitement in the last ring of the "V" tent. Almost everyone was standing on their chairs. "No wonder everyone is standing up," cried Ann. An attractive midget wearing a red dress has a sign hanging in front of her. It is a big white sign with a large black dot in the center. The dot looks just like our period (.) that we use at the end of sentences. The barker then introduced the midget clown as Dot (.), the only midget clown in the whole world who can do special tricks with her baton. Dot (.) twirled the baton over her head, between her legs, and in every direction. She was great! Ann shouted, "Boy-oh-boy, I wish I could do as well with my baton as Dot (.) does." Soon the children learned that Dot (.) had another important responsibility at this circus for she directed the circus crowd out of the tent to the eXit door. Dot (.) always stood on the top of the stairway pointing downstairs to the eXit door.

(.)
X

This was the end of the Cyber-Circus fun. But in a way it is only the beginning for there are so many things to learn and do all the children agreed. Eva, Tom, Ann, and Mother thought the barker was right -- it was "The Greatest Show on Earth."

Note: The story of the "V" tent would appear as follows:

"V" tent	Jay	Kangaroo	Dot (.)	---	J K
	Q (rope)	Zzz (bee)	eXit	---	Q Z X

APPENDIX D

Language Arts Exercises

Parts 1 and 2

APPENDIX D

The following instructional materials on Language Arts have been prepared by the teaching staff, under the direction of Mrs. Anna Mae Gallagher. It was designed for use with Cyber-Circus, one of the story guides for teaching children to communicate. These exercises have been prepared in the hope that they will provide and assist the educator and the student.

The Language Arts exercises are planned to provide reinforcement in the following three ways: manually by typing the letters; auditorily by reading aloud what is typed; and visually.

The task of operating the mechanism is a means toward several ends, including the promotion of the child's understanding of language structure and use; increasing the child's dexterity; facilitating retention; enlarging the child's potential for academic achievement; and providing the child a means for effective communication.

Language Arts Exercises
Part 1

Exercises for letters: E T A
O N I

a
an
ant
at
ate
eat
eaten
I
in
inn
into
it
neat
nee
net
nine
nit
no
none
noon
not
note
oat
on
one
onto
onion
tan
tea
tee
ten
tent
tie
tin
tine
tint
to
toe
too
toot
ton
tote

Phrases

a neat note
a neat tent
a tan net
a tan tint
no tea at noon
not one tie
ate at nine
ate at noon
ate at one
ate one onion
eaten at noon

Sentences

Anne ate one onion.
Iona eats in a tent.
Nan ate at noon.
I note Toni in a tent.
At noon Tina ate a tan onion.
Toot a note, Anna.

Exercises for letter: R

air
are
area
art
ear
enter
entire
inner
ire
iron
nor
oar
or
ore
rain
rant
rare
rear
rein
rent
roar
roe
root
rot
rotten
tar
tart
tear
tier
tore
torn
train
treat
tree

Phrases

near a rare tree
trot into a tent
enter an iron train
rent one tent
roar in an ear

Sentences

Rita ran to a train.
Rent one tent near a tree, Irene.
A rat ate a rotten tree root.
Roni, enter the art area.
I rent the rear tent.

Language Arts Exercises
Part 1

Exercises for letters: S
C

ace
ascent
across
acts
case
cast
castle
center
coast
coats
concise
consent
consist
cost
crease
crest
crisis
crisscross
entrance
incense
inches
insect
nose
once
scat
scatter
scene
scoot
screen
seats
secret
since
state

Phrases

increase in cost
into an arena
across the street
once at a race
a crisscross screen
on a scooter

Sentences

Casie sits in a car.
Rosco can score in a race.
Oscar ran in a secret race.
A scooter ran into an arena.
Rose ran across the street.
Cora can coast on a scooter.

Exercises for letters: H
L

catch
chair
channel
chill
circle
clash
cloth
clothes
colt
hail
hair
hare
hall
halt
heal
health
heel
he'll
hello
hen
hill
hole
hotel
lather
letter
lose
ninth
school
teacher
teeth
tenth
that
three
thrill

Phrases

halt the hare
hole in the cloth
on that hill
the tenth chair

Sentences

Helen is honest.
Hello, Hal, here is a hen.
There is a hotel on that hill.
The children are in school.

Language Arts Exercises
Part 1

Exercises for letters: D
M

admit
almond
arm
children
demote
dim
dime
dismal
dismiss
dome
doom
door
dorm
drama
dream
ice cream
ladder
ladies
mad
made
maid
maiden
medal
medicine
method
midget
mild
modern
modest
red

Phrases

a modern dance
mailed a card
across the area
a late dismissal
a mild medicine

Sentences

Madeleine did a modern dance.
Morris smiled at the maiden.
Millie is a dress model.
Tom ate an almond.
Mother made a modest dress.

Exercises for letter: U

aloud
amount
announce
audience
aunt
church
circus
curl
cut
cute
discuss
due
dues
duet
dull
dust
hour
hum
human
hundred
mud
mule
mum
music
null
nurse
nuts
ounce
out
rule
rude
sure
tuna
tune
turn
uncle
underline
unite
usual
utter

Phrases

at the usual hour
into our house
discuss the culture
less than an ounce
around the church

Sentences

Ursula met us at the usual hour.
The church music can be heard here.
Ruth's aunt ate almond nuts.
The teacher discussed the music.
Sue's child cut a curl.
The Dutch children are cute.

Language Arts Exercises
Part 1

Exercises for letters: F
B

balance
ball
baton
beautiful
bee
beef
before
belief
benefit
blue
bottom
brief
busy
buy
fable
fabric
fast
feather
fifth
first
five
floor
football
forbid
forebode
forecast
fun
off
table
tumble

Phrases

before the forecast
on the football field
under the filbert tree
lost a felt belt
read a beautiful fable

Sentences

Fred had a football.
Bessie has beautiful fabric.
It is a benefit affair.
Beef is on the menu.
Brenda read a forecast.

Exercises for letters: P
G

airplane
big
ceiling
dog
eighth
finger
first
flag
gallop
gentlemen
goat
grape
greatest
green
grip
ground
group
gulp
imagine
leg
orange
page
parachute
parents
period
pig
pilgrim
plate
popcorn
puppet
purple
right
ring
spoon
spring
surprise
top

Phrases

only one page
to grasp a big goat
to gallop on green grass
eating an orange
to be surprised

Sentences

Peggy read only one page.
Poppo gripped the goat tightly.
He ate popcorn.
Flippo gulped in surprise.
The horse's gallop is fast on green grass.

Language Arts Exercises
Part 1

Exercises for letters: Y
W

always
away
brown
city
clown
country
cowboy
crowd
down
eye
gray
show
sway
sweaty
swim
wall
water
way
whinny
white
wide
woolly
worry
wrist
yawn

Phrases

was not early
back and forth
a cause for worry
always on time
mouth wide open

Sentences

Wayne is a worried boy.
Weary William was not early.
They bought yellow pears in the country.
We yawn when we are bored.
The white sweater was woolly.

Exercises for letter: V

above
active
advice
alive
brave
carve
cave
converse
dover
drive
everyone
favor
five
flavor
give
glove
have
hive
leaves
live
love
move
never
observe
oven
over
prove
river
save
seven
seventh
silver
solve
travel
verb
vest
via
vigor
vim
vine
violet
visit
vital
voice
vote

Phrases

above the cave
about your good advice
away from the bee hive
in a large vase
to visit friends

Sentences

David climbed above the cave.
November is my favorite month.
Mother gave me good advice.
Everett stayed away from the bee hive.
He put the violets in a large vase.
Vera loves to visit friends.

Language Arts Exercises
Part 1

Exercises for letters: J
Q

aqua
banjo
croquet
equal
injury
jail
jam
jealous
joint
joy
jump
jury
just
justice
project
quantity
quarrel
quart
quarter
quartet
queen
question
quiet
quilt
quip
quit
quite
quote
square

Phrases

on a quarter of the quilt
for a jury
a grand banjo
visit a jail
fair and just

Sentences

Mother worked on a quarter of the quilt.
The quartet met for a session.
They visited a jail.
Jay received a grand banjo.
The queen was fair and just.

Exercises for letters: K
Z

awake
bake
bank
barker
black
blanket
buzz
cake
cheek
clock
cookies
creak
creek
dark
dozen
drink
folks
fork
frozen
gaze
ink
joke
kangaroo
keen
keep
kennel
key
kindly
king
kitchen
kite
kitten
knee
knife
knock
knot
know
lazy
mark
monkey
puzzle
skates
skin
skinny
speak
tank
thank
think
trick
waltz
zebra
zero
zipper
zoo

Phrases

a dozen new blankets
to work puzzles
on the cut knee
the zebra at dusk
a skinny happy clown

Sentences

We bought a dozen new blankets.
Hazel loved to work puzzles.
The hunter saw a zebra at dusk.
On Thanksgiving we visited the zoo.
Frank was a happy skinny clown.

Language Arts Exercises
Part 1

Exercises for letter: Ẋ

anxious
ax
axis
axle
borax
box
boxer
climax
coax
duplex
excess
excite
excuse
exercise
exist
exit
expect
extra
fix
fixture
fox
index
mix
mixture
next
relax
six
taxes
taxi
X-ray

Phrases

to play the xylophone
was to have X-rays
from the taxi
with the lost boxer
find the exit

Sentences

Rex was anxious to play his xylophone.
Max a boxer was X-rayed.
Trixie looked both ways before she stepped out of the taxi.
The teacher will relax in Texas.
The tent has six exits.
Eva typed "o" with her index finger.

Language Arts Exercises
Part 2

Exercises for letters: E T A
O N I

anoint
anon
attention
atone
attain
inion
initiate
initiation
innate
intent
intention
intone
nation
neon
notion
oaten
taint
tat
tattoo
teeter
tenant
tenent
titian

Phrases

a tent tenant
in a neat tent
initiation at noon
intent on a tone
not a tint
no notion at noon
no tea in a tent

Sentences

Nat ate in a tent.
An ant ate an oat.
Tina ate at noon.
Iona ate a tan onion.
I note not one tie in a tent.
I note no tea in a tent.

Exercises for letter: R

anteater
aorta
area
arena
aria
arrant
eerie
entertain
entreat
errant
inertia
interior
iron
irritate
orate
oration
orator
orient
otter
retain
retire
retort
riot
rite
rotate
rote
tenor
terrain
terrier
terror
tiara
trio

Phrases

retain an orator
rent a neat inn
entertain Rita
irritate a terrier
retire an entertainer

Sentences

Ira, entertain Rita.
A terrier ran to Irene.
An anteater ate an ant.
A traitor ran near a train.
A terrier ran to a trainer.

Language Arts Exercises
Part 2

Exercises for letters: S
C

access
ascension
conscience
consent
constant
constrain
constrict
co-star
crescent
incisor
increase
scan
scenic
scent
science
scion
sect
secrete
section
soccer

Phrases

access to a scenic section
a section on science
a co-star in soccer
increase in cost

Sentences

There is a cost increase on scissors.
Rosco is a co-star in soccer.
Casie consents to act in a scene.
Science interests Oscar.
This is a scenic area.

Exercises for letters: H
L

alas
alcohol
aloha
athlete
athletic
cartoon
chess
chlorine
color
dishevel
enthrall
halter
heater
holler
hostess
hostile
lease
leash
leather
licence
lose

Phrases

near a heater
on a leather leash
a torn halter
a loose leash

Sentences

Lena is not near the heater.
Hal lost his leather leash.
His horse has a torn halter.
Hostile athletes holler.

Language Arts Exercises
Part 2

Exercises for letters: S
C

access
ascension
conscience
consent
constant
constrain
constrict
co-star
crescent
incisor
increase
scan
scenic
scent
science
scion
sect
secrete
section
soccer

Phrases

access to a scenic section
a section on science
a co-star in soccer
increase in cost

Sentences

There is a cost increase on scissors.
Rosco is a co-star in soccer.
Casie consents to act in a scene.
Science interests Oscar.
This is a scenic area.

Exercises for letters: H
L

alas
alcohol
aloha
athlete
athletic
cartoon
chess
chlorine
color
dishevel
enthrall
halter
heater
holler
hostess
hostile
lease
leash
leather
licence
lose

Phrases

near a heater
on a leather leash
a torn halter
a loose leash

Sentences

Lena is not near the heater.
Hal lost his leather leash.
His horse has a torn halter.
Hostile athletes holler.

Language Arts Exercises
Part 2

Exercises for letters: D
M

administrate
administrator
admiral
admire
admission
admittance
announcement
caramel
comma
demeanor
demerit
demise
democrat
demolish
demonstrate
determine
diamond
dilemma
dimension
direct
disarm
dither
domestic
dominate
domineer
dominoes
dramatic
mandolin
meditate
semicolon

Phrases

to see the administrator
a dramatic dream
to admire an admiral
in a dilemma
to elect a democrat

Sentences

Adam admired the administrator.
Madeline nominated a democrat.
Daniel made a dramatic scene.
Morris demonstrated his mandolin.
Delia had a little diamond.

Exercises for letter: U

accumulate
accurate
assure
circular
commune
communicate
cuddle
cue
culture
cuticle
dud
duster
Dutch
enthusiastic
hurdle
hustle
inclusive
insure
latitude
luminous
mulch
murmur
musical
mustard
mutual
numerate
return
shout
ulcer
uncertain
unanimous
ultimate
uranium

Phrases

cut the cuticle
mustard on rolls
issue nine circulars
to assure communication
an uncertain musical date

Sentences

Ruth had cut her cuticle.
He ordered mustard on his roll.
Ursula acted in a hit musical.
The horses returned to their hurdles.
She discussed a humorous lesson.

Language Arts Exercises
Part 2

Exercises for letters: F
B

baffle
baleful
befit
before
befuddle
beneficial
bifocal
bouffant
braille
breadfruit
buffalo
buffet
feeble
fabricate
fabulous
fibula
filbert
forehead
interface
transfer

Phrases

on a fabulous boat
read a beautiful fable
for a bouffant dress
under the nut tree
befuddle a buffalo
on the buffet table

Sentences

Bertha told a fabulous fable.
Fabian ate before the musical.
Francis sat under the filbert tree.
Brenda had friends here.
Bertha feeds her fish often.

Exercises for letters: P
G

afternoon
applause
campaign
clapping
delight
epigraph
fallen
gape
glee
grapple
grasp
happiness
inspection
megaphone
midget
opening
pageant
paragraph
pedigree
permission
photograph
photographer
picture
planning
platform
practice
privilege
program
progress
scampering
telegram
telegraph
triangle

Phrases

permission to practice the pageant
in a campaign photograph
opening the picture book
on the monument
in the third ring

Sentences

Gerald sent Peter a telegram.
"Gertrude is photogenic," said the photographer.
Poppo grappled with the goat.
The program in the third ring was good.

Language Arts Exercises
Part 2

Exercises for letters: Y
W

hyphen
identify
loyal
mystery
responsibility
shinny
sorry
sweetly
swiftly
swirl
wayfarer
wayward
weary
whimsy
wistfully
witty
yawl
yellow

Phrases	Sentences
a weary wayfarer	Whitney was a weary wayfarer.
in the swirling waters	The yellow circus wagon went away.
swiftly moving traffic	Yolanda yawned sleepily and retired early.
always punctual	Wayne was a witty actor.
a mystery ring	The third ring was a mystery ring.

Exercises for letter: V

absolve
achievement
activity
advancement
adventure
adverb
aviation
aviator
avocado
avoid
boulevard
capture
cavity
conversation
converse
convert
crevice
devout
favorite
improvement
movement
novice
observe
ovation
prevention
previous
proverb
rivalry
sieve
vagrant
valuable
veneer
vertical
vicinity
volunteer

Phrases	Sentences
about his advancement	Vincent told us about his advancement.
a favorite proverb	Vivian read her favorite proverb.
avocado in a bowl	Davy found an avocado in the bowl.
over the boulevard	Our ride along the boulevard was an adventure.
a previous conversation	They never volunteered to help.

Language Arts Exercises
Part 2

Exercises for letters: J
Q

aquamarine
aquarium
banquet
bouquet
conjunction
conquer
equator
equity
frequent
injunction
inquiry
jaundice
jonquil
juvenile
liquid
liquidate
protection
quality
quantity
quarantine
question
quiver
quotation
quotient
rejoice

Phrases

from the equator
from the jonquil bouquet
in large quantities
protection by a quarantine sign
about the new aquamarine

Sentences

James traveled south, toward the equator.
One diver quivered nervously before the show.
He preferred the best jonquils for her bouquet.
Julia enjoyed jam in large quantities.
In July, James asked a question about the new aquamarine.

Exercises for letters: K
Z

blizzard
bracket
dramatization
gazelle
handkerchief
kennel
kidney
kindred
knowledge
knuckle
lazily
likeness
lizard
lucky
maize
market
mezzanine
nuzzle
pocketbook
size
skirt
skull
skunk
smoke
spoken
squeeze
stocking
thick
thicket
track
truck
trunk
ukulele
week
wicker
wreck
zoology

Phrases

to study zoology
a truck wreck at noon
a pocketbook on the mezzanine floor
both the gazelle and the zebra
a smoked ham at the market
a ukulele player

Sentences

Franklin chose to study zoology.
Zelda was in a truck wreck at noon.
Kate purchased her pocketbook on the mezzanine floor.
Both the gazelle and the zebra are at the zoo.
Kenneth knows a ukulele player.

Language Arts Exercises
Part 2

Exercises for letter: X

axiom
bizarre
buxom
climax
complexion
context
crux
dextrose
exact
exaggerate
exalt
examine
example
exceed
exceed
excel
exception
exclamation mark
exchange
exclaim
exclude
exempt
exhibit
expect
expense
express
extract
flax
influx
lax
lexicon
luxury
maximum
oxygen
perplex
saxophone
texture
toxic
tuxedo
vex
wax

Phrases

to exchange a tuxedo
to examine the exhibit
with a clear complexion
the maximum expense
at the climax

Sentences

Max wished to exchange the tuxedo.
Xavier wanted to examine the exhibit.
Maxine had a very clear complexion.
Rex loved his new luxury home.
The maximum expense would exceed his budget.
An exclamation mark was used at the climax.

APPENDIX E

SELECTED DESCRIPTIONS OF SUBJECTS

SUBJECT A (Barney)	Male, 7 years - 3 months; (see Plate 1) average intelligence; entered program February 8, 1968; has had 23 half-hour sessions.
Interface	February 8: split interface CYBERTYPE®; April 2: similar interface with broader key tops and light-touch switches.
Performance	The following typewriter symbols and functions were learned; alphabet, a-z; numerals, 0-9; space; return; period; comma; shift lock and unlock.
Problems	Lack of energy; slope of body, caused by sclerosis; limited finger dexterity; hands sometimes slid off interface keys.
Comments	This child's lesson frequently shorter than standard length, due to lack of energy, plus the fact that his lesson was the last one before the lunch period; performance was increased from one or two words per session initially, to four or five sentences, his name, and several dates toward end of program.
Recommendations	Child should continue in program; support for child's arms should be considered.

SUBJECT B (Paul A)	Male, 7 years - 4 months; (see Plate 1) average intelligence; entered program February 8, 1968; has had 28 half-hour sessions.
Interface	February 8: standard solid CYBERTYPE® interface; end of March: similar interface with switches adjusted for hard-touch.
Performance	The following typewriter symbols and functions were learned: alphabet, a-z; space; return; period.
Problems	Slowness of working; lacking elbows he could not work his prostheses effectively toward his body.
Comments	Child showed marked improvement in word-attack skills by end of program; was able to spell previously unattainable words.
Recommendations	Interface should be raised and placed at an angle of about 30°; efforts should be made to speed child's response time; CYBERTYPE® lessons should be integrated with regular school work.

SUBJECT C (Julia)	Female, 8 years - 1 month; (see Plate 1) average or above intelligence; entered program February 6, 1968; has had 24 half-hour sessions.
Interface	February 6: standard CYBERTYPE® interface; February 15: split interface, with halves rotated 90° and two so-called "thumb" buttons put at the outside ends of the interface; February 29: split interface with thumb keys in regular central position.
Performance	The following typewriter symbols and functions were learned; alphabet, a-z; numerals, 0-9; space; return; shift lock and unlock; comma; period.
Problems	Motivating her to concentrate on the task at hand; child did not adjust to second interface, although she had no difficulty with the third.
Comments	Child used only the little fingers of each hand on the CYBERTYPE® , possibly due to insufficient muscle strength in other fingers; child strived for exceptional neatness in her work.
Recommendations	Attempts should be made to find out how much finger strength other fingers have, and to develop that strength with CYBERTYPE® exercises.

SUBJECT D (Paul E)	Male, 10 years - 3 months; (see Plate 1) educable mentally retarded; entered program February 6, 1968; has had 29 half-hour sessions.
Interface	February 6: standard CYBERTYPE® interface; February 29: split interface which was subsequently fastened together when motion appeared to disturb child.
Performance	The following typewriter symbols and functions were learned: alphabet, a-z; period; comma; shift lock and unlock; carriage return; and the numbers 0-9.
Problems	Child had perceptual problems in discriminating the upper keybank from the lower; this problem was remedied by applying gold tape to the upper keybank and red tape to the lower keybank, and by correspondingly coloring letters on sentence cards from which he typed; speech handicapped.
Comments	Child seemed particularly responsive to the instructional program and materials: Cyber-Circus.
Recommendations	Child should continue in program for symbolic and motor development with Cyber-Circus; participation should be frequently re-evaluated.

SUBJECT E (Joan)	Female, 12 years - 10 months; (see Plate 1) average or above intelligence; entered program February 20, 1968; has had 22 half-hour sessions.
Interface	February 20: standard CYBERTYPE® interface; March 12: "one-hand" interface.
Performance	All of the typewriter functions and symbols were learned.
Problems	On the initial interface, the child could not reach the two extreme positions with her one hand; the smaller interface (less than four inches square) resolved the problem with no difficulty; speech handicapped.
Comments	Thumb and index finger used for majority of positions on the keyboard; index and middle fingers used infrequently; the girl was a swift learner, very cooperative and good-humored.
Recommendations	The girl should continue in the program so that she may improve her speed (she has already learned to touch-type) and so she may teach other children to CYBERTYPE®.

APPENDIX F

FILM TRANSCRIPT

FILM TRANSCRIPT

TEACHING CYBERTYPE® TO HANDICAPPED CHILDREN AT THE BELLE WILLARD ELEMENTARY SCHOOL

Introduction: Haig Kafafian, CYBERNETICS RESEARCH INSTITUTE

"The film you are about to see was taken at the Belle Willard Elementary School in Fairfax, Virginia. It shows four of the five students who participated from February to June, 1968, in a CYBERNETICS RESEARCH INSTITUTE project at Belle Willard. This research was conducted through a grant authorized by the United States Department of Health, Education and Welfare. Mrs. Aurelia A. Howland, Principal, and Mr. Victor E. Cornacchione, Vice Principal, of the Belle Willard Elementary School, cooperated with CYBERNETICS RESEARCH INSTITUTE in this program and assisted in the selection of multiple-impaired children who appear in this presentation.

"Portrayed here is only one aspect of the educational research program underway at CYBERNETICS RESEARCH INSTITUTE, a non-profit research organization in the District of Columbia, one of whose objectives is directed toward advancements in education of multiple-impaired children through use of mechanisms and techniques which are part of an organized and intelligent system. One of these mechanisms and techniques which you are about to see the children using is known as CYBERTYPE®, which is a registered trademark name of a communication system for which a patent is pending.

"During the film, please direct your attention to the unusual manner in which the children operate these mechanisms. Note that they do not use the 49-key typewriter keyboard, but a 14-key keyboard. You will observe the children striking two keys at a time. Initially, without having seen the film, the operation of a keyboard using two keys simultaneously might appear complicated. However, the dual-keying system used allows a reduction of the area of the keyboard to about one-sixth the size of a standard keyboard, and has about 35 fewer keys than a typewriter keyboard. The small keyboard also permits remote control of a typewriter by prostheses or by other portions of the body. There is a split-interface keyboard, not shown in the film, where seven keys are mounted on each side of a wheelchair and are electrically connected to the mechanism.

(continued)

FILM TRANSCRIPT (continued)

"In still another configuration, clasps and/or gloves which are equipped with transducers are worn by the children. They are manipulated so that the appropriate contacts on transducers are touched to a surface. The child is taught the dual-fingering combinations required and after only a few hours of instruction they are able to type.

"Members of the CYBERNETICS RESEARCH INSTITUTE research staff have taught the children you are about to see. The teacher instructs the child how to use the mechanism with the aid of "Cyber-Circus" , instructional material used to introduce the dual-keying positions. The teacher explains that the letter "A" is a symbol representing "Ann", one of the characters in the circus story. The characters and objects in "Cyber-Circus" are translated into instructional materials. The story and the materials not only represent the individual letters but also indicate the position of these letters on the keyboard. For instance, Skinny the clown, is a character in the circus who rides a Colt. Representing the letters "S" and "C" are Skinny and the Colt, the one above the other just as the "S" and "C" keys appear on the interface where the "S" is above the "C".

"The children received between nine and twelve hours of instruction. The first child appearing in the film, Joan, is a twelve year-old with cerebral palsy. Previously, she had been taught to use a standard electric typewriter and, since one objective of the program was to learn to what extent children, who did not communicate by typing, could learn to operate the new mechanism, she was not originally chosen as a subject.

"Despite the fact that Joan knew how to type, the staff felt that it would be advantageous to have her as a subject. As a result, Joan was admitted into the program and after about seven hours of instruction, she was typing at twice her former speed. She was able to type five words per minute on the standard electric typewriter which she had used for four years and achieved a speed of ten words per minute on the 14-key interface after only seven hours of instruction.

"The last child you will see in the film is Paul, who was born armless and uses two prostheses. He has some facial paralysis and his visual acuity is questionable. When he typed, he brought his left eye to within two inches of his work; when he looked across the room, he squinted with his right eye. It was difficult for Paul to see and to use his prostheses. Since this film was made, Paul's interface has been raised and tilted to about a thirty-degree angle. This change allows him to type without bending

(continued)

over. Paul's teacher, Mr. Hilliard Aaron Carter, whom you will meet in the film, is a bilateral amputee with monocular vision. He has become expert at the operation of various interfaces used in the program and feels that the results of the program with Paul and the other children are commendable. As you will see, Paul, Joan, and the other children are using the mechanism to communicate, even at this early phase of the project. It is with this aspect of education that we are concerned: not whether we can turn out our children as typists, but how, and to what extent, these children can extend their educational capabilities, and to what extent we can help them communicate more effectively with their contemporaries.

"At this time I am pleased to introduce Mrs. Anna Mae Gallagher, author of Keyboard Town Story, who created the "Cyber-Circus" instructional material. She will give you her personal description of the teaching program conducted under her direction.

Moderator: Mrs. Anna Mae Gallagher

"Haig Kafafian, the principal investigator for this program, who made the preceding introduction, is president and director of research of CYBERNETICS RESEARCH INSTITUTE, and inventor of the "Cybercom" Systems used in this program. (1)

"In this film you will meet four children. The first child is Joan. This girl, twelve years old, is a cerebral-palsied youngster, wheelchair bound, yet cheerful. She is in the seventh grade at the Belle Willard Elementary School. An intelligent child and an ace student in her class, she plans to be a mathematician when she graduates from college.

"Her principle difficulty is an athetosis of her better hand, which is the left one. This condition is so severe on the right that the hand is almost useless. Since the 14-key interface requires dual inputs, I doubted at first that Joan, with the use of only one hand, could take part in the program. She sensed my uncertainty, and with her barely understandable speech convinced me that the thumb of her left hand could substitute for her right hand. She stretched her middle finger and thumb on the interface to verify her point, and struck two distant keys simultaneously.

(1) start film

(continued)

FILM TRANSCRIPT (continued)

"Since the interface used was too long for her finger expansion, she was provided with a smaller interface, measuring about four inches square, which is shown with Joan using it. This smaller interface proved to be most effective for our research purposes.

"In seven lessons (fifteen minutes to each session), Joan learned not only the letters on the typewriter keyboard, but also all the numbers, symbols, and operative functions of the typewriter. She typed with great speed and accuracy.

"Using "Cyber-Circus" as an instructional program presented a problem at first. Joan seemed so much older than her years, and the circus story, I realized was too juvenile for her. I re-cast the format of the story, replacing little Eva, Tom and Ann, the circus-goers, with adult Miss E. T. Allen, the director of the Office of the National Interests. Joan readily identified; she took on the responsibility of planning the acts and selecting the performers for the spring circus. In the story she also held several meetings to secure approval for her plan from members of the board.

"Joan became more outgoing and enthusiastic as the story and her typing progressed. One of the only two girls in a class of twelve children, she had seldom spoken in class and had not been friendly with the boys. All through school, she had been withdrawn and introverted. However, her silent ways began to disappear. She loved her importance in her new role. After each lesson, Joan returned to her class and related to everyone her agenda for the "Cyber-Circus". Her teacher was amazed at the great change in Joan's personality.

"Adding to her confidence, a 14-key interface was placed in her regular classroom. It helped her in her daily academic work. Her teacher appreciated her readable papers, and even the other students enjoyed her success. Laughingly, Joan related to me a tale about a test in spelling incident in her classroom. The boys, it seemed, had always had to wait for her as she wrote her words with a pencil during the spelling dictation. "Now," she said, "I have the words typed first, and I have to wait for them."

"At this point in the film, we see Paul, ten years old and a third grade student at the Belle Willard Elementary School. With a typical chorea-athetotic walk, he thumps with his legs and balances with his arms, which are in constant motion. His speech is dysarthric and he drools most of the time. His major difficulties are motor.

(continued)

FILM TRANSCRIPT (continued)

"At first, Paul had a hard time controlling his fingers on the interface keys. Struggling with him for ten sessions, my efforts and his efforts seemed almost hopeless. Regardless of all the difficulties, he struggled on. Anxious to please his teacher, he listened to every suggestion and worked as hard as he could.

"All of a sudden, on the thirteenth lesson, Paul performed beautifully. He had mastered the "Cybercode", and had gained good finger control on the 14-keys. We were both thrilled. Once he had finally succeeded in his efforts, he became greatly interested in seeing what he had typed; his improvement continued throughout the rest of the program.

"Paul learned the concept of space -- or upper and lower positions of the keys -- by means of color. In order to help him distinguish the upper keybank from the lower keybank, we put colored tape, gold and red, on the appropriate interface keys. We also crayoned corresponding colors on the letters on the word-cards from which he typed. We felt that this color association worked well with him. In no instance did we label the symbols or letters on the key tops.

"As they tired easily, the boy's arms needed support while he was typing. A book we placed on his desk as a temporary support solved this problem. (Appropriately enough, the book was a dictionary). CYBERNETICS RESEARCH INSTITUTE plans to design a more adequate arm rest for Paul before he re-enters the program in September of 1968.

"I am immensely proud of Paul, as much as I am with all the children, and his determination to learn. Part of his drive came from the motivating circus story and the related games which we played. He loved the circus characters and objects, and always made sure to spend time with them at the close of each session. He and the other children learned beautifully through play, almost without consciousness of the fact that they were learning something "real" as well as something "make-believe."

"Toward the end of the program, when Paul's lessons were over, he would not stop typing. 'Just two more sentences,' he would say. This was real music to my ears.

(continued)

FILM TRANSCRIPT (continued)

"This portion of the film shows Julie, eight years old, allegedly deformed through the use of the drug thalidomide, was born without legs. She has four fingers, extending medially from wing-like arms, and no thumbs. Her only "strong" finger is her little finger on each hand, which, as you see, she uses to push down the interface keys. She also has a great hearing loss, with little or no hearing in her right ear. She lip-reads most of the time.

"This little girl, Julie, has a delightful personality; she was always pleasant, outgoing, concerned about her classmates, and fascinated by stories and games. She even "flirted" with the film photographer! "Did you get my pretty dress in your picture, sir?" she asked: "I want you to know it is my very newest one."

"Her doctor suggested that Julie be removed from her wheelchair to a special desk for the lessons. Attendants at the school rendered that service, and the youngster would be settled after about ten minutes of squirming and chattering.

"Julie learned rapidly all the letters, numbers, symbols and operations on the typewriter keyboard in eighteen lessons (about four and a half hours)! She typed fast, with great assurance, and like Paul, never wanted to stop typing when her period was over.

"Both in the same classroom, Paul and she were constantly vying with one another. "And how did Paul do today?" Julie would ask. I devised a little "baseball" game for them. According to the rules of the game when they typed a sentence without error, they made a home run. This game put their competitive spirits gainfully to work. At the end of one session wherein she had performed particularly well, I said to the child, "You know what, Julie? You are the home run queen."

She had very little difficulty, once she managed to use those little fingers, and as I mentioned, worked with assurance. Seldom ever was there an error in her work. She was proud of that. When she typed with the machine, her papers were extremely neat, with even the margins carefully planned.

"If she used too much pressure on the keys, "bouncing" would occur, and the letters would double. To correct this doubling, I taught her to quickly raise her fingers off the keys, which she did, for she was always on guard against errors.

(continued)

FILM TRANSCRIPT (continued)

"She wanted to see her work right after she typed it, and insisted on inspecting it herself. A little praise was usually required, and regularly given. We reserved a happy five minutes at the end of each lesson for playing with the circus characters. Julie had great fun arranging new and exciting circus acts.

"At the end of the term, I surprised her by having the interface brought into her classroom, where she typed for the children in her class. She was all excited. She arranged the children in a circle so that they could see what she was doing. It was a significant occasion for Julie.

"Here we see another student, also named Paul.

"He stayed up late at night many times, and was often tired at school. It took a great deal of motivating to "get him going" originally.

"At first he worked all bent over. Mr. Kafafian corrected the situation by raising the interface so that the boy could reach it easily while he rested his back against the chair for support.

"Paul and his instructor, Mr. Carter, who also uses two prostheses, worked together admirably as a team.

"At first Paul could not get his prostheses onto the interface keys, but with effort and practice he became skilled in using the mechanism. Like most children, he was pleased to be able to do something which other children could not do.

"The boy's name, you will notice is attached to his interface. According to each child's handicap an interface was used which matched the child's capabilities. Each of the young subjects seemed to enjoy having his name on "his own" personal interface.

"After the typing lesson, Paul would spend about five minutes in the classroom playing with the toy circus characters and objects. The circus had been assembled from standard, commercially available toys with the help of the students. The children associated all the acts, performers and objects with symbols, functions and letters of the alphabet as introduced on the 14-key interface.

"Paul had trouble at times handling the toy ladder, which usually had a toy hen perched on it to represent "H" over "L" on the interface. Every suggestion he made for arranging the toys I felt was important for him to enact, and I gave assistance when

(continued)

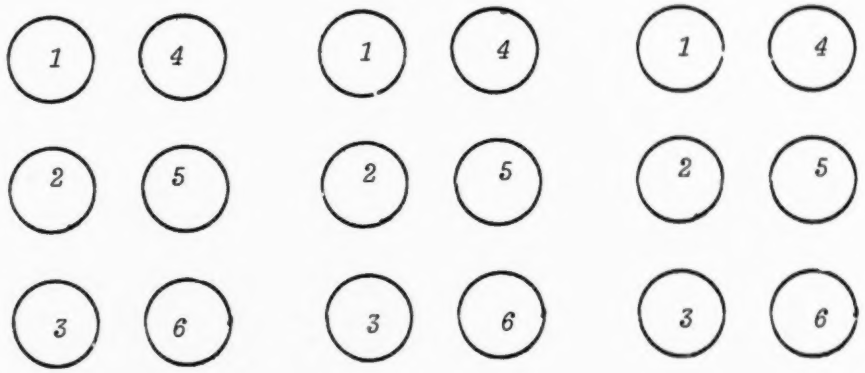
FILM TRANSCRIPT (continued)

it was necessary. In one instance while playing he was determined to get the kangaroo, which represented the letter "K", on the ladder! He not only had an associative play session, but he also had effective physical therapy. Later he learned to assemble many acts all by himself.

"I am very proud, as all of us are, of all of these seriously multiple-impaired children and their well-earned successes. Perhaps they worked harder than we did, and I know that they enjoyed participating in the program as much as we delighted in working with them."

APPENDIX G

HAIBRL CELL FUNCTIONS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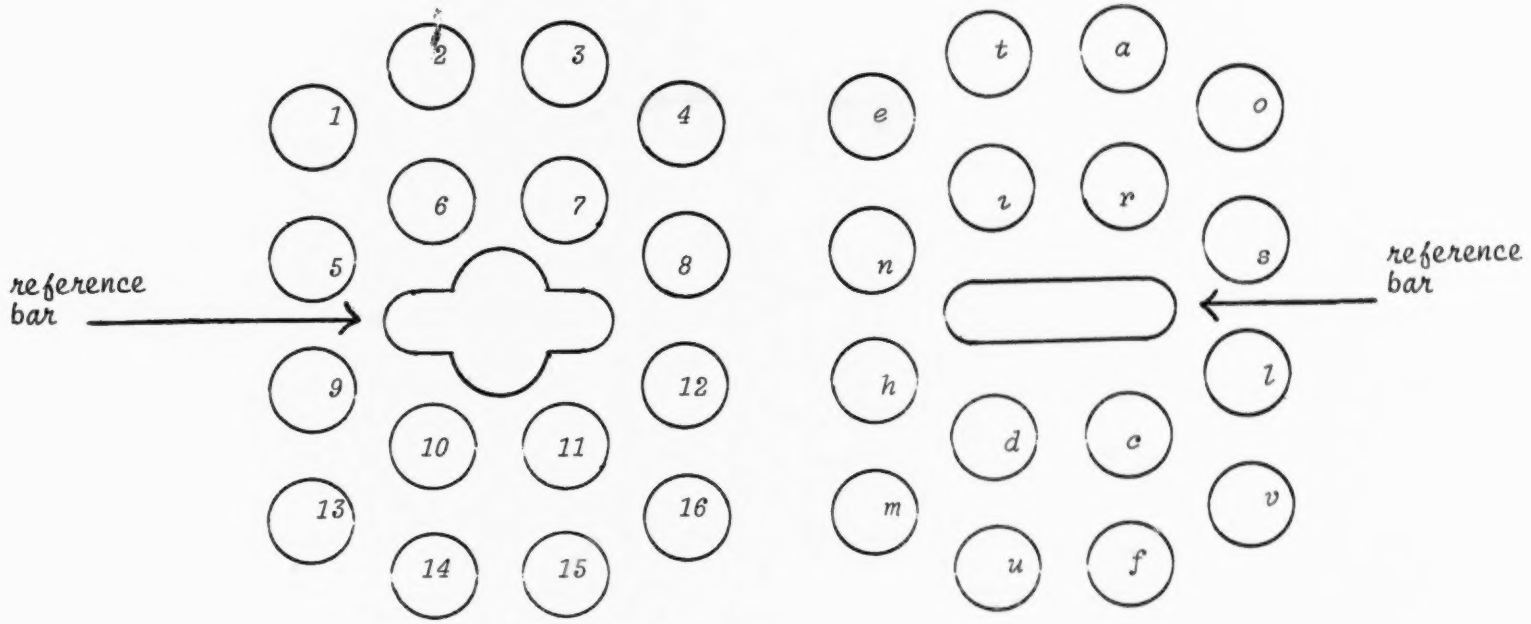
Standard Braille Cells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Experimental HAIBRL Cells
CHART 6.

TABLE II

SINGLE AND DUAL DOT HAIBRL CELL FUNTIONS

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TABLE III

THREE DOT HAIBRL CELL FUNCTIONS

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TABLE III - THREE DOT HAIBRL CELL (Continued)

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TABLE III - THREE DOT HAIRBL CELL (Continued)

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APPENDIX H

LETTERS

BELLE WILLARD ELEMENTARY SCHOOL
A FAIRFAX COUNTY SCHOOL
3752 OLD LEE HIGHWAY
FAIRFAX, VIRGINIA 22030

December 20, 1967

Mr. Haig Kafafian
Cybernetics Research Institute
2321 Wisconsin Avenue, N.W.
Washington, D. C.

Dear Sir:

This letter is to inform you that I will soon be contacting parents of those students who seem likely candidates for participation in this experimental - developmental program. The possibilities of your equipment are most interesting and we look forward to our association with you and other members of your staff.

Sincerely,

Victor E. Cornacchione

Victor E. Cornacchione,
Assistant Principal

Fairfax County Public Schools

10700 Page Avenue, Fairfax, Virginia 22030 • Telephone 273-6500
E. C. Funderburk, *Division Superintendent*

May 23, 1968

Office of Instruction

Mr. Kafafian
Cybernetics Research Institute
2321 Wisconsin Ave., N.W.
Washington, D. C.

Dear Sir:

I would like to take this opportunity to congratulate you and your staff for the research you are conducting in the area of exceptional children. Perhaps this will be the break-through that will unlock the door for things for handicapped youngsters. Your staff and you have been most generous with your time and energy in the individual cases that I have sent to you for exploration.

I hope that you will continue to explore the field of electronics in producing devices and material that will make it possible for exceptional children to overcome their handicaps.

Sincerely,

Helen B. Jacoby

Helen B. Jacoby
Supervisor of Special Education

HBJ:ph

(COPY)

May 23, 1968

MEMORANDUM

To: W. Harold Ford, Assistant Superintendent for Instruction
Virginia B. Benson, Director of Elementary Education
Helen B. Jacoby, Supervisor of Special Education
Haig Kafafian, Director, CRI

From: Aurelia A. Howland, Principal
Victor E. Cornacchione, Assistant Principal

Subject: Summary of CRI Cybertype Developmental Program

1. CRI (Cybernetics Research Institute, a non-profit research organization, sponsored by the U.S. Office of Education, HEW) is developing a computerized keyboard interface to be used with standard electric typewriters. Margaret Moss, Associate Professor at George Washington University, one of CRI's educational consultants, made initial contact with Belle Willard on November 22, 1967, about the possibility of using some few students in the developmental stages of this machine. Mrs. Moss was introduced by Mrs. Helen Jacoby who indicated that future contacts between the school and CRI should be direct. The next few months involved a series of organization meetings.

2. The possibilities of electronic technology in helping overcome some of the communication problems of orthopedically impaired children certainly seemed to warrant the school's cooperation. A total of five children were selected for inclusion in a developmental program, and parents were contacted for written permission for their child's participation and for CRI's access to school information. This program is known as Cybertype.

3. Tentative program work began on February 6, 1968, and the children now meet with CRI personnel for 1/2 hour twice weekly. Meetings are also held with parents as necessary.

(Copy)

May 23, 1968

Page 2 - Summary of CRI Cybertype Developmental Program

4. CRI, as an organization, is growing. They hope to continue this developmental program at Belle Willard next year. Their tentative plans are to do research with control and experimental groups. A continued association in this project is worthy of consideration; however, CRI's pending continuous grant from the U.S. Office of Education will need supplement from the local level. Project forms are being sent to CEEC for their consideration about this program.

5. The present phase of this developmental program will conclude at the end of this month. Parents of the students in the program will be given an evaluation of their child's role; they will also be offered the opportunity to have their child receive summer instruction, without cost, in the Cybertype program at CRI's office in Washington.

6. One example of progress by an individual in this program is a child who has typed one-handed on a standard electric keyboard for several years. This child learned the Cybertype method in the course of several weeks; this particular student now types almost twice as rapidly with the CRI developmental interface.

7. Enclosed is a copy of CRI's petition to the U.S. Office of Education for the continuance of their grant. It should be noted that the main purposes and interests of CRI are the developmental aspects of Cybertype.

8. In conclusion, it can be stated that this has been a successful and cooperative beginning effort in the development of a new type of equipment in the field of educational technology. It is hoped that the Department of Instruction will assist in obtaining local funds in order that this program can continue.

VEC/j

APPENDIX I

ERIC REPORT RESUME

OE 6000 (REV. 9-66)

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF EDUCATION

ERIC REPORT RESUME

ERIC ACCESSION NO.

CLEARINGHOUSE ACCESSION NUMBER

RESUME DATE 08-19-68

P.A.

T.A.

IS DOCUMENT COPYRIGHTED? YES ☐ NO ☐

ERIC REPRODUCTION RELEASE? YES ☐ NO ☐

TITLE

STUDY OF MAN-MACHINE COMMUNICATIONS SYSTEMS FOR THE HANDICAPPED

PERSONAL AUTHOR(S)

Haig Kafafian

INSTITUTION (SOURCE)

Cybernetics Research Institute, Washington, D. C.

SOURCE CODE

REPORT/SERIES NO.

OTHER SOURCE

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OTHER REPORT NO.

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OTHER REPORT NO.

PUB'L. DATE 08-19-68

CONTRACT/GRANT NUMBER OEG 2-7-070533-4237

PAGINATION, ETC. Trade-mark Names: HAIBRL, Cybercom, Cybertype, Cyberphone, Cyberlamp, Cyberview, Cybersem, Cyberplate, Cybercode, Cybertac, Cybergenetics, Cyberbrailler, Cybergloves

RETRIEVAL TERMS

Education, Special Education, Handicapped Children, Disabled Persons, Instructional Material, Cybernetics, Cybertype®, Typewriters, Man-Machine Communications Systems, Computers, Displays, Deaf, Blind, Amputees, Cerebral Palsy, Wheelchair, Pattern Recognition, Programming Codes, Keyless Keyboard, HAIBRL

IDENTIFIERS

ABSTRACT

Cybernetics Research Institute's studies anent feasibility of communications systems for exceptional children include: (1) "Cybercom"; (2) CYBERTYPE ®; a subsystem of "Cybercom"; (3) "Cyberplate", a keyless keyboard; (4) "Cyberphone", a telephonic communication system for deaf and speech-impaired persons; (5) "Cyberlamp", a visual display; (6) "Cyberview", a fiber optic bundle remote visual display; (7) "Cybersem", an interface for the blind, fingerless, and others with limited control; (8) "Cybertac", a tactile communications technique for the blind, utilizing palpable vibrations; (9) " Cyberbrailler", a system for simultaneous printing of braille and typed letters via "Cybercode" dual-inputs; (10) "Cybergloves", transducer-fitted gloves for "Cybercode" applications to "Cybercom" systems, and (11) HAIBRL, an unambiguious punctiform tactile communication system utilizing reference perforations.

Three blind, five multipe-impaired, two bilateral amputees, and two deaf subjects were tested on the new mechanisms using experimental instructional materials. The latter include: (1) Cybertype® Excercise Series, aimed to improve dexterity and motor recall; (2) A child's circus story-guide presenting performers and objects which represent letters of the alphabet, symbols and machine functions, according to "Cybercode", a dual-input program; (3) Language Arts Excercises, which relate instructional materials with classwork.

Initial results clearly demonstrate worthiness and utility of the research.